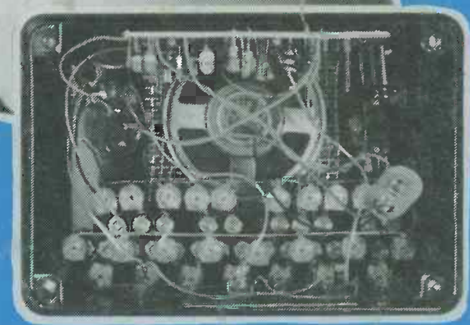
# RADIO & ELECTRONICS CONSTRUCTOR

OCTOBER 1979
50p

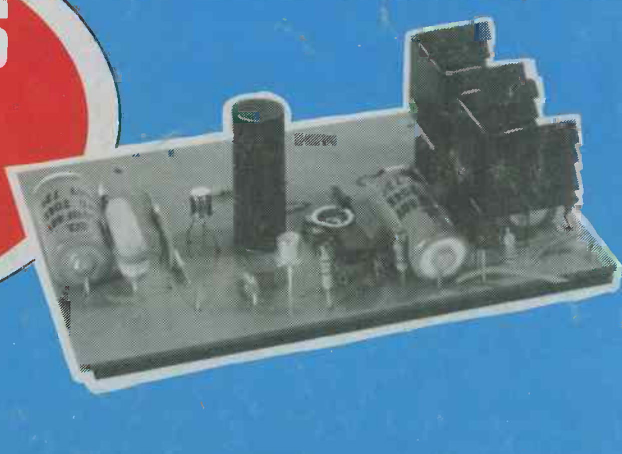
# STYLUS ORGAN

EASY-TO-BUILD MONOPHONIC ELECTRONIC ORGAN WITH SWITCHABLE VIBRATO

# 10 watts Vmos AMPLIFIER

POWER F.E.T. CLASS B OUTPUT WITH NEGATIVE TEMPERATURE CO-EFFICIENT



**ALSO FEATURED**

**ULTRA-SIMPLE QUIZZ SELECTOR**

4-1-79

## DIODES/ZENERS

| QTY. | | | | |
|---|---|---|---|---|
| | 1N914 | 100v | 10mA | .05 |
| | 1N4005 | 600v | 1A | .08 |
| | 1N4007 | 1000v | 1A | .15 |
| | 1N4148 | 75v | 10mA | .05 |
| | 1N4733 | 5.1v | 1 W Zenner | .25 |
| | 1N4749 | 24v | 1W | .25 |
| | 1N753A | 6.2v | 500 mW Zener | .25 |
| | 1N758A | 10v | " | .25 |
| | 1N759A | 12v | " | .25 |
| | 1N5243 | 13v | " | .25 |
| | 1N5244B | 14v | " | .25 |
| | 1N5245B | 15v | " | .25 |
| | 1N5349 | 12v | 3W | .25 |

## SOCKETS/BRIDGES

| QTY. | | | | | |
|---|---|---|---|---|---|
| | 8-pin | pcb | .16 | ww | .35 |
| | 14-pin | pcb | .20 | ww | .40 |
| | 16-pin | pcb | .25 | ww | .45 |
| | 18-pin | pcb | .30 | ww | .95 |
| | 20-pin | pcb | .35 | ww | 1.05 |
| | 22-pin | pcb | .40 | ww | 1.15 |
| | 24-pin | pcb | .45 | ww | 1.25 |
| | 28-pin | pcb | .50 | ww | 1.35 |
| | 40-pin | pcb | .55 | ww | 1.45 |
| | Molex pins | .01 | To-3 Sockets | | .35 |
| | 2 Amp Bridge | | 100-prv | | .95 |
| | 25 Amp Bridge | | 200-prv | | 1.50 |

## TRANSISTORS, LEDS, etc.

| QTY. | | | |
|---|---|---|---|
| | 2N2222M | (2N2222 Plastic .10) | .15 |
| | 2N2222A | | .19 |
| | 2N2907A | PNP | .19 |
| | 2N3906 | PNP (Plastic) | .19 |
| | 2N3904 | NPN (Plastic) | .19 |
| | 2N3054 | NPN | .55 |
| | 2N3055 | NPN 15A 60v | .60 |
| | T1P125 | PNP Darlington | 1.95 |
| | LED Green, Red, Clear, Yellow | | .19 |
| | D.L.747 | 7 seg 5/8" High com-anode | 1.95 |
| | MAN72 | 7 seg com-anode (Red) | 1.25 |
| | MAN3610 | 7 seg com-anode (Orange) | 1.25 |
| | MAN82A | 7 seg com-anode (Yellow) | 1.25 |
| | MAN74 | 7 seg com-cathode (Red) | 1.50 |
| | FND359 | 7 seg com-cathode (Red) | 1.25 |

## 9000 SERIES

| QTY. | | | QTY. | | |
|---|---|---|---|---|---|
| | 9301 | .85 | | 9322 | .65 |
| | 9309 | .50 | | 9601 | .30 |
| | | | | 9602 | .45 |

## MICRO's, RAMS, CPU's, E-PROMS

| QTY. | | |
|---|---|---|
| | 8T13 | 2.50 |
| | 8T23 | 2.50 |
| | 8T24 | 3.00 |
| | 8T97 | 1.75 |
| | 74S188 | 3.00 |
| | 1488 | 1.25 |
| | 1489 | 1.25 |
| | 1702A | 4.50 |
| | AM 9050 | 4.00 |
| | ICM 7207 | 6.95 |
| | ICM 7208 | 13.95 |
| | MPS 6520 | 10.00 |
| | MM 5314 | 4.00 |
| | MM 5316 | 4.50 |
| | MM 5387 | 3.50 |
| | MM 5369 | 2.95 |
| | TR 1602B | 3.95 |
| | UPD 414 | 4.95 |
| | Z 80 A | 22.50 |
| | Z 80 | 17.50 |
| | Z 80 P10 | 10.50 |
| | 2102 | 1.45 |
| | 2102L | 1.75 |
| | 2107B-4 | 4.95 |
| | 2114 | 9.50 |
| | 2513 | 6.25 |
| | 2708 | 11.50 |
| | 2716 D.S. | 34.00 |
| | 2716 (5v) | 69.00 |
| | 2758 (5v) | 26.95 |
| | 3242 | 10.50 |
| | 4116 | 11.50 |
| | 6800 | 13.95 |
| | 6850 | 7.95 |
| | 8080 | 7.50 |
| | 8085 | 22.50 |
| | 8212 | 2.75 |
| | 8214 | 4.95 |
| | 8216 | 3.50 |
| | 8224 | 4.25 |
| | 8228 | 6.00 |
| | 8251 | 7.50 |
| | 8253 | 18.50 |
| | 8255 | 8.50 |
| | TMS 4044 | 9.95 |

## – T T L –

| QTY. | | | QTY. | | | QTY. | | | QTY. | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 7400 | .20 | | 7492 | .45 | | 74H20 | .25 | | 74LS76 | .70 |
| | 7401 | .20 | | 7493 | .35 | | 74H21 | .25 | | 74LS86 | .95 |
| | 7402 | .20 | | 7494 | .75 | | 74H22 | .40 | | 74LS90 | .85 |
| | 7403 | .20 | | 7495 | .60 | | 74H30 | .30 | | 74LS93 | .85 |
| | 7404 | .20 | | 7496 | .80 | | 74H40 | .35 | | 74LS96 | 2.00 |
| | 7405 | .35 | | 74100 | 1.15 | | 74H50 | .30 | | 74LS107 | .90 |
| | 7406 | .25 | | 74107 | .35 | | 74H51 | .30 | | 74LS109 | 1.50 |
| | 7407 | .55 | | 74121 | .35 | | 74H52 | .20 | | 74LS123 | 1.95 |
| | 7408 | .20 | | 74122 | .55 | | 74H53 | .25 | | 74LS138 | 2.00 |
| | 7409 | .25 | | 74123 | .55 | | 74H55 | .25 | | 74LS151 | .95 |
| | 7410 | .20 | | 74125 | .45 | | 74H72 | .35 | | 74LS153 | 1.15 |
| | 7411 | .25 | | 74126 | .45 | | 74H74 | .35 | | 74LS157 | 1.15 |
| | 7412 | .25 | | 74132 | .75 | | 74H101 | .95 | | 74LS160 | 1.15 |
| | 7413 | .45 | | 74141 | .90 | | 74H103 | .55 | | 74LS164 | 2.90 |
| | 7414 | .75 | | 74150 | .85 | | 74H106 | 1.15 | | 74LS193 | 2.00 |
| | 7416 | .25 | | 74151 | .95 | | 74L00 | .30 | | 74LS195 | 1.15 |
| | 7417 | .40 | | 74153 | .95 | | 74L02 | .30 | | 74LS244 | 2.90 |
| | 7420 | .25 | | 74154 | 1.15 | | 74L03 | .35 | | 74LS259 | 1.50 |
| | 7426 | .25 | | 74156 | .70 | | 74L04 | .40 | | 74LS298 | 1.50 |
| | 7427 | .25 | | 74157 | .65 | | 74L10 | .30 | | 74LS367 | 1.95 |
| | 7430 | .20 | | 74161/9316 | .75 | | 74L20 | .45 | | 74LS368 | 1.25 |
| | 7432 | .30 | | 74163 | .85 | | 74L30 | .55 | | 74LS373 | 2.50 |
| | 7437 | .20 | | 74164 | .75 | | 74L47 | 1.95 | | 74S00 | .45 |
| | 7438 | .30 | | 74165 | 1.10 | | 74L51 | .65 | | 74S02 | .45 |
| | 7440 | .20 | | 74166 | 1.75 | | 74L55 | .85 | | 74S03 | .35 |
| | 7441 | 1.15 | | 74175 | .90 | | 74L72 | .65 | | 74S04 | .35 |
| | 7442 | .55 | | 74176 | .95 | | 74L73 | .70 | | 74S05 | .45 |
| | 7443 | .45 | | 74177 | 1.10 | | 74L74 | .75 | | 74S08 | .45 |
| | 7444 | .45 | | 74180 | .95 | | 74L75 | 1.05 | | 74S10 | .45 |
| | 7445 | .75 | | 74181 | 2.25 | | 74L85 | 2.00 | | 74S11 | .45 |
| | 7446 | .70 | | 74182 | .75 | | 74L93 | .75 | | 74S20 | .35 |
| | 7447 | .70 | | 74190 | 1.25 | | 74L123 | 1.95 | | 74S22 | .55 |
| | 7448 | .50 | | 74191 | 1.25 | | 74LS00 | .40 | | 74S40 | .30 |
| | 7450 | .25 | | 74192 | .75 | | 74LS01 | .40 | | 74S50 | .30 |
| | 7451 | .25 | | 74193 | .85 | | 74LS02 | .45 | | 74S51 | .35 |
| | 7453 | .20 | | 74194 | .95 | | 74LS03 | .45 | | 74S64 | .15 |
| | 7454 | .25 | | 74195 | .95 | | 74LS04 | .45 | | 74S74 | .70 |
| | 7460 | .40 | | 74196 | .95 | | 74LS05 | .45 | | 74S112 | .60 |
| | 7470 | .45 | | 74197 | .95 | | 74LS08 | .45 | | 74S114 | .85 |
| | 7472 | .40 | | 74198 | 1.45 | | 74LS09 | .45 | | 74S133 | .85 |
| | 7473 | .25 | | 74221 | 1.50 | | 74LS10 | .45 | | 74S140 | .75 |
| | 7474 | .30 | | 74298 | 1.50 | | 74LS11 | .45 | | 74S151 | .95 |
| | 7475 | .35 | | 74367 | 1.35 | | 74LS20 | .45 | | 74S153 | .95 |
| | 7476 | .40 | | 75491 | .65 | | 74LS21 | .45 | | 74S157 | .98 |
| | 7480 | .75 | | 75492 | .65 | | 74LS22 | .45 | | 74S158 | .80 |
| | 7481 | .85 | | 74H00 | .20 | | 74LS32 | .50 | | 74S194 | 1.50 |
| | 7482 | .95 | | 74H01 | .30 | | 74LS37 | .45 | | 74S196 | 2.00 |
| | 7483 | .95 | | 74H04 | .30 | | 74LS38 | .65 | | 74S257 (8123) | 2.50 |
| | 7485 | .75 | | 74H05 | .25 | | 74LS40 | .70 | | 8131 | 2.75 |
| | 7486 | .55 | | 74H08 | .35 | | 74LS42 | .95 | | | |
| | 7489 | 1.05 | | 74H10 | .35 | | 74LS51 | .75 | | | |
| | 7490 | .55 | | 74H11 | .25 | | 74LS74 | .95 | | | |
| | 7491 | .70 | | 74H15 | .45 | | 74LS75 | 1.20 | | | |

## C MOS

| QTY. | | | QTY. | | | QTY. | | | QTY. | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 4000 | .15 | | 4017 | .75 | | 4034 | 2.45 | | 4069 74C04 | .45 |
| | 4001 | .20 | | 4018 | .75 | | 4035 | .75 | | 4071 | .25 |
| | 4002 | .25 | | 4019 | .35 | | 4037 | 1.80 | | 4081 | .30 |
| | 4004 | 3.95 | | 4020 | .85 | | 4040 | .75 | | 4082 | .30 |
| | 4006 | .95 | | 4021 | .75 | | 4041 | .69 | | 4507 | .95 |
| | 4007 | .25 | | 4022 | .75 | | 4042 | .65 | | 4511 | .95 |
| | 4008 | .75 | | 4023 | .25 | | 4043 | .50 | | 4512 | 1.50 |
| | 4009 | .35 | | 4024 | .75 | | 4044 | .65 | | 4515 | 2.95 |
| | 4010 | .35 | | 4025 | .25 | | 4046 | 1.25 | | 4519 | .85 |
| | 4011 | .30 | | 4026 | 1.95 | | 4047 | 2.50 | | 4522 | 1.10 |
| | 4012 | .25 | | 4027 | .35 | | 4048 | 1.25 | | 4526 | .95 |
| | 4013 | .40 | | 4028 | .75 | | 4049 | .65 | | 4528 | 1.10 |
| | 4014 | .75 | | 4029 | 1.15 | | 4050 | .45 | | 4529 | .95 |
| | 4015 | .75 | | 4030 | .30 | | 4052 | .75 | | MC14409 | 14.50 |
| | 4016 | .35 | | 4033 | 1.50 | | 4053 | .95 | | MC14419 | 4.85 |
| | | | | | | | 4066 | .75 | | 74C151 | 2.50 |

## I²L, LINEARS, REGULATORS, ETC.

| QTY. | | | QTY. | | | QTY. | | |
|---|---|---|---|---|---|---|---|---|
| | MCT2 | .95 | | LM320K24 | 1.65 | | LM373 | 3.95 |
| | 8038 | 3.95 | | LM320T5 | 1.65 | | LM377 | 3.95 |
| | LM201 | .75 | | LM320T12 | 1.65 | | 78L05 | .75 |
| | LM301 | .45 | | LM320T15 | 1.65 | | 78L12 | .75 |
| | LM308 | .65 | | LM323K | 5.95 | | 78L15 | .75 |
| | LM309H | .85 | | LM324 | 1.25 | | 78M05 | .75 |
| | LM309 (340K-5) | 1.50 | | LM339 | .75 | | LM380 (8-14 Pin) | 1.19 |
| | LM310 | .85 | | 7805 (340T5) | 1.15 | | LM709 (8-14 Pin) | .45 |
| | LM311 (8-14 Pin) | .75 | | LM340T12 | .95 | | LM711 | .45 |
| | LM318 | 1.50 | | LM340T15 | .95 | | LM723 | .40 |
| | LM320H6 | .79 | | LM340T18 | .95 | | LM725 | 2.50 |
| | LM320H15 | .79 | | LM340T24 | .95 | | LM739 | 1.50 |
| | LM320H24 | .79 | | LM340K12 | 1.25 | | LM741 (8-14) | .45 |
| | 7905 (LM320K5) | 1.65 | | LM340K15 | 1.25 | | LM747 | 1.10 |
| | LM320K12 | 1.65 | | LM340K18 | 1.25 | | LM1307 | 1.75 |
| | LM320K15 | 1.65 | | LM340K24 | 1.25 | | LM1458 | .65 |
| | | | | | | | LM3900 | .95 |
| | | | | | | | LM75451 | .65 |
| | | | | | | | NE555 | .45 |
| | | | | | | | NE556 | .85 |
| | | | | | | | NE565 | 1.15 |
| | | | | | | | NE566 | 1.25 |
| | | | | | | | NE567 | .95 |
| | | | | | | | TA7205 | 6.95 |
| | | | | | | | 76477 | 2.95 |
| | | | | | | | 95H90 | 9.95 |

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Telex #697-827 ICUSD SDG

HOURS: 9 A.M. - 6 P.M. MON. thru SUN.

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| $301-$1000 | 20% |

# RADIO & ELECTRONICS CONSTRUCTOR

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No. 2

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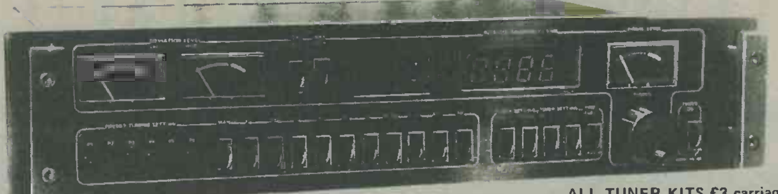
**THE NOVEMBER ISSUE WILL BE PUBLISHED ON 4th OCTOBER**

# Tecknowledgey for sale.

## The Mark III FM Tuner

DIY Hi-Fi will never seem the same again. Ambit's Mark III tuner system is electrically & visually superior to all others. Some options available, but the illustrated version with reference series modules: £149.00 + £18.62 VAT

With Hyperfi Series modules £185.00 + £23.12



ALL TUNER KITS £3 carriage

**Features of the system:**

- Precision construction & design of all parts
- Time/frequency display
- State of the art performance with facilities for updates, using modular plug in systems.
- Deviation level calibrator for recording
- All usual tuner features

## Digital Dorchester All Band Broadcast Tuner: LW/MW/SW/SW/SW/FM stereo

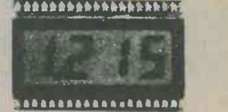
A multiband superhet tuner, constructed using a single IC for RF/IF processing - but with all features you would expect of designs of far greater complexity. The FM section uses a three section (air gang) tuned FET tunerhead, with ceramic IF filters and interstation mute; AM employs a double balanced mixer input stage, with mechanical IF filters - plus a BFO and MOSFET product detector for CW/SSB reception. Styled in a matching unit to the Mark III FM only tuner, employing the same degree of care in mechanical design to enable easy construction. MW/LW reception via a ferrite rod antenna.

| | |
|---|---|
| Electronics only (PCB and all components thereon) | £33.00 + £4.95 VAT |
| Complete with digital frequency readout/clock-timer hardware | £99.00 + £14.85 VAT |
| Complete with MA1023 clock/timer module with dial scale | £66.00 + £9.90 VAT |

*Hardware packages are available separately if you wish to house your own designs in a professional case structure. Please deduct the cost of electronics from complete prices.*

## LW MW FM LCD Digital Frequency Display - July PW feature

Update your old radio, or build this into a new design. Or use it as a servicing aid - this low power unit with LCD display reads direct frequency in kHz/MHz, or with usual AM/FM IF offsets for received frequency. Low power LCD means no RFI - 15-20mA at 9v even with the divide by 100 prescalar. FM resolution is 100kHz, AM 1kHz. Sensitivities better than 10mV



Complete kit £19.50 + £2.93 VAT, built and tested module £27.00 + £4.05VAT

*Ambit stocks and distributes a wide range of frequency counter LSI for all types of DFM- part two of the catalogue contains details of the MSM5523/4/5/6 range, and the versatile MSL2318 divide by ten or hundred prescalar IC. The DFM1 combined counter for AM,FM SW and direct/clock/stopwatch/timers - details available, but SAE please !*

## PW SANDBANKS PI METAL LOCATOR

Maintaining our professional approach to home constructor kits, we offer the pulse induction 'Sandbanks'. Now with injection molded casing for greatly improved enviromental sealing. £37.00+£5.55vat

## VHF MONITOR RX WITH PLESSEY IC

4/9 channel version of the PW design but using standard (fundx9) crystals, and TOYO 8 pole crystal filter with matching transformers. Coil sets from our standard range to cover bands from 40 to 200MHz. Complete module kit £31.25 +£3.90vat.

## MICROMARKET

OSTS overflow:

| | | | | | |
|---|---|---|---|---|---|
| 6800P | 650p | 8212 | 230p | 2102 | 170p |
| 6820P | 600p | 8216 | 195p | 2112 | 340p |
| 6850P | 275p | 8224 | 350p | 2513 | 754p |
| 6810 | 400p | 8228 | 478p | 4027 | 578p |
| 6852 | 365p | 8251 | 625p | 2114 | 1000p |
| 8080 | 630p | 8255 | 540p | +15% VAT | |

## RADIO and AUDIO MODULES : Consistently the most advanced

**FOR FM**

EF5801-3-4 series: 6 stage varicap tuning, all with oscillator output

| | | |
|---|---|---|
| 5801 | Dual gate MOSFET RF stages, bipolar mixer | £17.45 + 2.61VAT. |
| 5803 | Dual gate RF/mixer stages, amplified LO out | £19.75 + 2.96VAT |
| 5804 | 'Hyperfi' series, with internal PIN diode agc, and ultra wide range tuning system | £24.95 + 3.74VAT |
| EF5402 | 4 stage varicap tuner with TDA1062 and LO output. Uses FET/IC input. PIN agc | £10.75 + 1.61VAT |

**FOR 30-200MHz**

The EF series are available on special order to cover bands (usually approx 20% of the centre frequency) in the range described. Details in our price list.

**FOR FM IFs at 10.7MHz**

| | | |
|---|---|---|
| 7030 | single 6 pole linear phase filter IF with HA1137 | £10.95 + 1.64VAT |
| 7130 | two 6 pole linear phase filter IF with CA3189E | £16.25 + 2.44VAT |
| 7230 | Hyperfi IF, switched bandwidth, AGC IF preamp, linear phase ceramic filters with diode switched narrow filter | £24.95 + 3.74VAT |

**DECODERS for MPX (STEREO)**

Various types, guaranteed the world's biggest and best ranges

**LARSHOLT FM TUNERSETS**

| | | |
|---|---|---|
| 7252 | MOSFET front end combined with CA3089 IF | £26.50 +3.97VAT. |
| 7252 | JFET front end, combined with IF and decoder | £26.50 +3.97VAT |

FM/AM tuning synthesiser, see details elsewhere in this advertisement

## COMPONENTS FOR RADIO/COMMUNICATIONS/AUDIO/TV etc.

As usual, Ambit brings you the latest and best, a small selection of which is shown in this advertisement. The Ambit catalogues contain information on most of the devices mentioned here - and an order for the new part three will ensure you stay up with latest developments. Data photocopying service described in pricelist info.

| RADIO ICs for FM | | vat |
|---|---|---|
| CA3089E | 1.94 | 29 |
| CA3189E | 2.45 | 37 |
| HA1137W | 2.20 | 33 |
| HA11225 | 2.20 | 33 |
| SN76660N | 0.75 | 11 |
| **RADIO ICs for AM/FM** | | |
| TDA1090 | 3.35 | 50 |
| TDA1083 | 1.95 | 29 |
| TDA1220 | 1.40 | 21 |
| **IF AMPLIFIERS** | | |
| KB4406 | 0.50 | 07 |
| MC1350 | 1.20 | 18 |
| see comms ics also | | |
| **COMMUNICATIONS** | | |
| KB4412 | 2.55 | 38 |
| KB4413 | 2.75 | 41 |
| SD6000 | 3.75 | 56 |

| SL1600 series | | |
|---|---|---|
| SL1610 | 1.60 | 24 |
| SL1611 | 1.60 | 24 |
| SL1612 | 1.60 | 24 |
| SL1613 | 1.89 | 28 |
| SL1620 | 2.17 | 33 |
| SL1621 | 2.17 | 33 |
| SL1623 | 2.44 | 37 |
| SL 624 | 3.28 | 49 |
| SL1625 | 2.17 | 33 |
| SL1626 | 2.44 | 37 |
| SL1630 | 1.62 | 24 |
| SL1640 | 1.89 | 28 |
| SL1641 | 1.89 | 28 |
| SL6640 | 2.75 | 41 |
| SL6690 | 3.20 | 48 |
| MC3357 | 3.12 | 47 |
| MC1496 | 1.25 | 19 |
| NE544 | 1.70 | 25 |

| Audio preamps | | vat |
|---|---|---|
| LM381N | 1.81 | 27 |
| LM382N | 1.65 | 25 |
| KB4436 | 2.53 | 38 |
| KB4438 | 2.22 | 33 |
| TDA1028 | 3.50 | 53 |
| TDA1029 | 3.50 | 53 |
| TDA1074 | 3.75 | 56 |
| **Audio power** | | |
| TBA820M | 0.75 | 11 |
| TBA810AS | 1.09 | 16 |
| LM380N | 1.00 | 15 |
| ULN2283 | 1.00 | 15 |
| TDA2002 | 1.95 | 29 |
| HA1370 | 2.99 | 45 |
| TDA2020 | 2.99 | 45 |

2SJ133/2SJ48 £10.00 + £1.50 pr. various high voltage drivers etc. from correctly matched Hitachi series transistors. (All 120v types)

FETs, MOSFETs, bipolars. and various others: see PL

OSTS: Remember all OSTS stocks are obtained from BS9000 approved sources - your assurance that all devices are very best first quality commercial types. Some LPSN TTL is presently in great demand, so please check by phone before ordering .

## TTL:Standard AND LP Schottky

All prices listed in pence *

| | 'N' | 'LSN' | | 'N' | 'LSN' | | 'N' | 'LSN' | | 'LSN' |
|---|---|---|---|---|---|---|---|---|---|---|
| 7400 | 13 | 20 | 7472 | 28 | | 74142 | 265 | | 74257 | 108 |
| 7401 | 13 | 20 | 7473 | 32 | 38 | 74143 | 312 | | 74260 | 153 |
| 7402 | 14 | 20 | 7474 | 27 | 38 | 74144 | 312 | | 74273 | 124 |
| 7403 | 14 | 20 | 7475 | 38 | 40 | 74145 | 65 | 97 | 74283 | 120 |
| 7404 | 14 | 20 | 7476 | 37 | 38 | 74147 | 175 | | 74293 | 95 |
| 7405 | 18 | 26 | 7478 | | 38 | 74148 | 109 | 191 | 74365 | 49 |
| 7406 | 38 | | 7480 | 48 | | 74150 | 99 | | 74366 | 49 |
| 7409 | 17 | 24 | 7481 | 86 | | 74151 | 64 | 84 | 74367 | 43 |
| 7410 | 15 | 24 | 7482 | 69 | | 74153 | 64 | 54 | 74368 | 49 |
| 7411 | 20 | 24 | 7485 | 104 | 99 | 74154 | 96 | | 74373 | 77 |
| 7412 | 17 | | 7486 | | 40 | 74155 | 54 | 110 | 74374 | 77 |
| 7413 | 30 | | 7489 | 205 | | 74156 | 80 | 110 | 74377 | 124 |
| 7414 | 51 | | 7490 | 33 | 90 | 74157 | 67 | 55 | 74379 | 130 |
| 7415 | | 24 | 7491 | 76 | 110 | 74158 | | 60 | 74393 | 140 |
| 7416 | 30 | | 7492 | 38 | 78 | 74159 | 210 | | | |
| 7417 | 30 | | 7493 | 32 | 99 | 74160 | 82 | 130 | | |
| 7420 | 16 | 24 | 7494 | 78 | | 74161 | | 78 | | |
| 7421 | 29 | 24 | 7495a | 65 | 99 | 74162 | | 130 | | |
| 7423 | 27 | | 7496 | 58 | 120 | 74163 | 92 | 78 | | |
| 7425 | 27 | | 7497 | 185 | | 74164 | 104 | 130 | | |
| 7426 | | 27 | 741XX series | | | 74165 | 105 | | | |
| 7427 | 27 | 29 | 74107 | 32 | 38 | 74167 | 20 | | | |
| 7428 | 35 | 32 | 74109 | 63 | 38 | 74169 | | 200 | | |
| 7430 | 17 | 24 | 74110 | 54 | 54 | 74170 | 230 | 200 | | |
| 7432 | 25 | 24 | 74111 | 68 | | 74172 | 625 | | | |
| 7437 | 40 | 24 | 74112 | | 38 | 74174 | 87 | 120 | | |
| 7438 | 33 | 24 | 74113 | | 38 | 74175 | 87 | 110 | | |
| 7440 | 17 | 24 | 74114 | | 38 | 74176 | 75 | | | |
| 7441 | 74 | | 74116 | 198 | | 74177 | 78 | | | |
| 7442 | 70 | 99 | 74118 | 83 | | 74181 | 165 | 350 | | |
| 7443 | 115 | | 74120 | 115 | | 74183 | | 210 | | |
| 7444 | 112 | | 74121 | 25 | | 74184 | 135 | | | |
| 7445 | 94 | | 74122 | 46 | | 74185 | 134 | | | |
| 7446 | 94 | | 74123 | 46 | | 74188 | 275 | | | |
| 7447 | 82 | 89 | 74124 | | 137 | 74190 | | 92 | | |
| 7448 | 56 | 99 | 74125 | 38 | 44 | 74192 | 105 | 180 | | |
| 7449 | | 99 | 74126 | 57 | 44 | 74193 | 105 | 180 | | |
| 7451 | 17 | 24 | 74128 | 74 | | 74194 | 105 | | | |
| 7453 | 17 | | 74132 | 73 | 78 | 74196 | 99 | 110 | | |
| 7454 | 17 | 24 | 74136 | | 40 | 74197 | | 110 | | |
| 7455 | 35 | 24 | 74138 | | 60 | 74198 | 150 | | | |
| 7460 | 17 | | 74139 | | 60 | 74199 | 160 | | | |
| 7463 | | 124 | 74141 | 56 | | 74247 | | 90 | | |
| 7470 | 28 | | | | | 74253 | | 105 | | |

**VOLTAGE REGS:**

| | |
|---|---|
| 7800 series 1Amp pos | 95p |
| 7900 series 1Amp neg | 100p |
| 78M series ½Amp pos | 90p |
| 78LCP 100mA | 35p |
| 78MGT2C variable | 175p |
| 79MGT2C variable | 175p |
| 723CN variable IC | 65p |
| NE550 | 73p |
| L200 variable V and I | 195p |

**MAINS EMI FILTERS**

(BS etc approved types)

| | |
|---|---|
| 1 Amp in IEC chassis connector | 4.83 |
| 6 Amp in IEC | 5.83 |
| 5 Amp wirein | 3.87 |

(Toroid cores in Cat no. 2)

**MISC. Counter/timer, scalar devices..........**

NE555 30p NE556 78p NE558 180p

LM3909 72p

| | |
|---|---|
| 95H90DC divide by 10/11 to 320MHz | 780p |
| 11C90DC divide by 10/11 to 650MHz | 1400p |
| 8629 divide by 100 to 175MHz min | 420p |
| MSL2318 divide by 10/100 to 175MHz min | 420p |
| ICM7216BIPI : 8 decade 10MHz DFM counter and full function timer, with direct drive for an LED display (mpx). Uses 10MHz xtal | 1982p |
| ICM7217AIBI ; 4 decade programmable counter with direct LED drive | 950p |
| ICM7207 clock pulse generator | 495p |
| ICM7208 : 7 decade counter display | 1495p |
| ICM7106CP : LCD DVM (3½ digit) | 955p |
| ICM7106CPK : evaluation kit for 7106 | 24.80 |
| ICM7107CP : LED DVM (3½ digit) | 955p |
| ICM7107CPK : LED DVM kit for 7107 | 20.65 |
| OKI MSM5523/4 : LED/Fluorescent display driver IC for time/timer/stopwatch/ AM/FM received frequency display and direct counter (use MSL2318 prescalar) inc Crystal | 1400p |
| MSM5525 : AM/FM frequency only couner, for fluorescent displays (6LT06) inc xtal | 1100p |
| MSM5526 : as MSM5525 but for LCD | 1100p |
| 4 digit LCD for ICM7106 or MSM5526 | 1100p |
| 10 LED (2½x5mm) bar graph driver PCB for LOG or LIN (specify). Kit ex leds | 300p |

IMPORTANT: ALL PRICES SHOWN EXCLUDE VAT - WHICH MUST BE ADDED AT 15% OVERALL. PLEASE NOTE THE REDUCED CMOS/LPSN TTL RANGES DUE TO CURRENT SUPPLY SHORTAGE

## CD4000

| | | | |
|---|---|---|---|
| 4000 | 17 | 4522 | 149 |
| 4001 | 17 | 4528 | 102 |
| 4002 | 17 | 4529 | 141 |
| 4006 | 109 | 4532 | 125 |
| 4007 | 18 | 4538 | 150 |
| 4008 | 80 | 4539 | 110 |
| 4009 | 58 | 4543 | 174 |
| 4010 | 58 | 4549 | 399 |
| 4011 | 17 | 4554 | 153 |
| 4012 | 17 | 4558 | 117 |
| 4013 | 55 | 4560 | 218 |
| 4014 | 95 | 4562 | 530 |
| 4016 | 52 | 4566 | 159 |
| 4017 | 80 | 4568 | 281 |
| 4018 | 80 | 4569 | 303 |
| 4019 | 60 | 4572 | 25 |
| 4020 | 93 | 4584 | 63 |
| 4021 | 82 | 4585 | 100 |
| 4022 | 90 | | |
| 4023 | 17 | | |
| 4024 | 76 | | |
| 4025 | 17 | | |
| 4026 | 180 | | |
| 4027 | 55 | | |
| 4028 | 72 | | |
| 4029 | 100 | | |
| 4030 | 58 | | |
| 4035 | 120 | | |
| 4040 | 83 | | |
| 4042 | 85 | | |
| 4043 | 85 | | |
| 4044 | 80 | | |
| 4046 | 130 | | |
| 4048 | 60 | | |
| 4049 | 55 | | |
| 4050 | 55 | | |
| 4051 | 65 | | |
| 4052 | 65 | | |
| 4053 | 65 | | |
| 4055 | 135 | | |
| 4059 | 563 | | |
| 4060 | 115 | | |
| 4063 | 109 | | |
| 4066 | 53 | | |
| 4068 | 25 | | |
| 4069 | 20 | | |
| 4070 | 20 | | |
| 4071 | 20 | | |
| 4072 | 20 | | |
| 4073 | 20 | | |
| 4075 | 20 | | |
| 4076 | 90 | | |

**LINEARS**

| | |
|---|---|
| CA3130E | 84 |
| CA3130T | 90 |
| CA3140E | |
| CA3140T | 72 |
| LM301AH | 67 |
| LM301AN | 30 |
| LM339N | 66 |
| LM348N | 186 |
| LM3900N | 60 |
| 709HC | 64 |
| 709PC | 36 |
| 710HC | 65 |
| 710PC | 59 |
| 723CN | 65 |
| 741CH | 66 |
| 741CN | 27 |
| 747CN | 70 |
| 748CN | 36 |
| NE531N | 105 |

**7 SEG DISPLAYS**

HP5082 series.......

| | | |
|---|---|---|
| Red | 7650 | 233p |
| | 7653 | 233p |
| Yell | 7660 | 233p |
| | 7663 | 233p |
| Grn | 7670 | 233p |
| | 7673 | 233p |
| Fairchild FND 500/507 | | 150p |

## MORE FROM THE GENERAL AMBIT CATALOGUE RANGES:

Varicap tuning diodes for AM/FM/TV :

1-9 v AM tuning (Cr 15:1) from TOKO–

| | | | |
|---|---|---|---|
| KV1211 | double matched | 175p | 26p vat |
| KV1210 | triple matched | 245p | 37p vat |
| KV1215 | triple snap-apart | 245p | 37p vat |
| MVAM115 | single 15v | 105p | 16p vat |
| MVAM125 | single 25v | 105p | 16p vat |
| MVAM2 | double 25v | 148p | 22p vat |
| BB204/104 | double FM | 40p | 6p vat |
| BA102 | single AFC etc | 30p | 4p vat |
| BA121/ITT210 | single afc | 30p | 4p vat |
| BB105B | single UHF | 40p | 6p vat |
| **PIN DIODES, BANDSWITCH types** | | | |
| BA479 | PIN attenuator | 35p | 5p vat |
| TDA1061 | Pi-form atten. | 95p | 14p vat |
| BA182 | Bandswitch | 21p | 3p vat |

*All RF semiconductors stocked in depth. Please ask for quantity pricing details.*

**MPU controllable digital freq. synthesiser PCB. Preliminary:**

Serial data controlled, with the standard swallow count system for maximum speed of operation. Multiple time constant filters, suitable for AM/FM and other communications/generator applications. Not for beginners. Full preliminary data package £1 + SAE. No phone enquiries answered on this system for the time being. Watch this space........ Projected cost of the controller PCB less than £30: comprises the two modulus counter, prog.div., phase detector, multiple TC loop filter/integrators.

**TOP GRADE LEDS by AEG: PRICES ARE EXC. VAT (add 15%)**

| SIZE | Red | Green | Yello | Orang |
|---|---|---|---|---|
| 5mm | 14p | 16p | 15p | 20p |
| 3mm | 13p | 15p | 18p | 19p |
| 2½x5 | 17p | 20p | 20p | 24p |

Quantity discounts for LEDs:
10 per type - less 10%
100 per type - less 30%
100 mix in 10s - less 25%

**FUTABA FLUORESCENT VACUUM DISPLAYS for CLOCKs etc**

| | | |
|---|---|---|
| 5LT02 | clock display (static drive) with AM/PM flags | £9 + 1.35 |
| 5LT03 | DFM display for MSM5525 LSI counter | £9.45 + 1.42 vat |
| 6LT06 | 5 digit DFM display (GI AY58100) mpxed | £9.75 +1.46 vat |

**TOKO COILS, FILTERs, CHOKES, etc for AM/FM/TV comms–**

( please add VAT @15%)

| TYPE | Size: 5mm | 7mm | 10mm | |
|---|---|---|---|---|
| AM IF | 55p | 33p | 30p | Various for ICs, transistor etc. |
| FM IF | 55p | 33p | 33p | Various for ICs, transistor etc. |
| SW coils | | | 33p | Two impedance series |
| OSC coils | 55p | 33p | 33p | For LW/MW/SW |
| TV vif/sif | | | 35p | |

Various coils in the range 20kHz to 300MHz - see TOKO catalogue

**CERAMIC and MECHANICAL FILTERS (MURATA TYPES)**

CFT455B/ CFT455C 60p; CFX014 -180p; CFU455C - 85p
CFT470C- 60p; CFU470C -65p
MURATA CFU455H and CFU455F cermic block filters 1.95ea
MURATA CFM455 series ladder filters. D,E,F,G,H bandwidths available now (20,16,12,8,6 kHz) £8.35 ea (metal encapsulated)
SFD455B, SFD470B, SFD472B 85p ea
CFM2 series mechanical elements types A,B,C,D (4-10kHz bandwidth) - 65p ea. (As used in RCME feature)

**MULTIPLEX/PILOT TONE FILTERS, FM IF FILTERS (see cat and:)**

| | |
|---|---|
| CFSE10.7/SFE10.7 - stereo FM IF ceramic filters (sim FM4 etc) | 50p |
| CFSB10.7/SFE10.7MJ - mono bandwidth ceramic FM IF filters | 50p |
| SFE10.7ML - ultra linear phase stereo ceramic IF filters | 70p |
| CDA10.7 - 10.7MHz ceramic discriminator (for CA3089 etc) | 70p |

Current news: A PCB for the Mullard DC tone and volume control system is now available £3 + 0.45 VAT. HMOS PA modules for 60-100W - kit £14 +£2.10VAT, heatsink £4.10+0.61. FM radio control system crystals £3.75 pair inc VAT (Sept.on). MK50366N: static drive clock/timer IC £3.78 + 0.57 VAT. 12½kHz channel spacing 8 pole 10.7MHz XTAL filter by TOYO type H4402 £15.50 + £2.32VAT. A further updated pricelist is now available, and we would like to remind you that enquiries can only be answered if accompanied either by an official business letterhead, or an SAE. STOP PRESS: TOKO's new split-apart triple AM tuning diodes are in stock £2.45 + 37p VAT, (KV1215). S BL1 diode DBM 1-500MHz - £4.25+0.64p.

Terms: CWO please. Account facilities for commercial customers OA. Postage 25p per order. Minimum credit invoice for account customers £10.00. Please follow instructions on VAT, which is usually shown as a separate amount. Overseas customers welcome - please allow for postage etc according to desired shipping method. Access facilities for credit purchases.

Catalogues: Ambit. Part 1 45p. Part 2 50p 90p pair. TOKO Euro shortform 20p. Micrometals toroid cores 40p. All inc PP etc. Full data service described in pricelist supplements.

Hours/phone: We are open from 9am -7pm for phone calls. Callers from 10am to 7pm. Administrative enquiries 9am to 4.30pm please (not Saturdays). Saturday service 10am to 6pm.

AMBIT catalogues are guaranteed to contain the most up-to-date and best informed comment on modern developments and advances in the field of radio and audio. There is no competetive publication that even approaches the broad range of parts/information on modern techniques.

**ambit® international 2 Gresham Road, Brentwood, Essex.**

100 Electrolytics ........ £3.00
100 Resistors 1W ......... £2.00
100 Wirewound Resistors £4.50
*Well mixed values and voltages*

100 Capacitors .......... £2.50
100 Resistors up to ¼W £1.00
100 Resistors 2-5W .... £3.00
100 1% & 2% Resistors £3.50

C90 Cassette Tape 62p

Mullard +12-0-12V 1A, 4A stabilized, regulated, power supply. £12.50 September Offer £9.00

27V 5A Double section bobbin transformer £4.50

50 ohm BNC through connector or round or flanged chassis socket. TNC plug or N plug or through connector 65p each

250 Ω 50 watt + Resistor 40p

UK — Postal Orders for same day service. Cheques require 8 days from a Tuesday banking to ensure clearance: export — banker's draft (sterling) same day service. Foreign currency money orders etc. can lose value and take 4-6 weeks to clear.

## SEMICONDUCTORS Full spec. by Mullard etc. Many others in stock

| | |
|---|---|
| AC126/128/176 | 16p |
| ACY20 | 30p |
| ACY29 | 22p |
| AD161/2 match pr. | 85p |
| ADZ12 | £4.00p |
| AF124/6/7 | 28p |
| AF139 | 23p |
| AF178/80/81 | 35p |
| AF239 | 35p |
| ASY27/73 | 35p |
| AU110/113 | £1.51 |
| BC107/8/9 + A/B/C | 8p |
| BC147/8/9 + A/B/C | 5p |
| BC157/8/9 + A/B/C | 5p |
| BC171B/173 | 8p |
| BC178A/B 179B | 14p |
| BC182/184C/LC | 5p |
| BC186/7 | 23p |
| BC204 | 12p |
| BC212 | 5p |
| BC213L/214B/238 | 13p |
| BC327/8 337/8 | 8p |
| BC547/8+A/B/C | 10p |
| BC556/7/7B/8/9 | 11p |
| BCX32/36 | 15p |
| BCY31 | 59p |
| BCY40 | 55p |
| BCY70/1/2 | 14p |
| BCZ11 | 32p |
| BD113 | 57p |
| BD115 | 35p |
| BD116(BRC116T) | 86p |
| BD130Y | £1.50 |
| BD131/2 | 32p |
| BD133/5/6/7/8/9 | 35p |
| BD137/138 match pr | 82p |
| BD140/142 | 35p |
| BD201/2/3/4 | 86p |
| BD232/3/4/5/8 | 45p |
| BDX77 | 97p |
| BD437/438 | 58p |
| BF/115/167/173 | 18p |
| BF178/9 | 23p |
| BF180/1/2/3/4/5 | 18p |
| BF194/5/6/7 | 5p |
| BF194A, 195C | 5p |
| BF258/324 | 13p |
| BF262/3 | 35p |
| BF336/274 | 31p |
| BFS28 Dual Mosfet | £1.15 |
| BFT61 | 40p |
| BFW10/11 F.E.T | 46p |
| BFW30 | £1.15 |
| BFW57/58 | 21p |
| BFX12/29/30 | 23p |
| BFX84/88.89 | 20p |
| BFY50/51 | 13p |
| BFY90 | 50p |
| BR101 | 34p |
| BRY39/56 | 29p |
| BSV64 | 36p |
| BSV79/80 F.E.T.s | 50p |
| BSV81 Mosfet | 75p |
| BSX20/21/78 | 16p |
| BSY40 | 30p |
| BSY95A | 14p |
| BU204+Mount Kit | £1.51 |
| BU208 | £2.05 |
| CV7042 (OC41/44 ASY63) | 12p |
| GET111/E112 | 45p |
| OC45(ME2) | 13p |
| ON222 | 23p |
| R2008B/2010B | £1.80 |
| TIP30 | 35p |
| TIS43 (2N2646) | 24p |
| µA7805 Reg.TO3 | 55p |
| ZT1486 | £1.15 |
| ZTX300/341 | 9p |
| 2N393 (MA393) | 35p |
| 2N456A | 57p |
| 2N706A | 13p |
| 2N918 | 30p |
| 2N929 | 16p |
| 2N987 | 45p |
| 2N1484 | £1.15 |
| 2N1507/2219 | 18p |
| 2N1613 | 24p |
| 2N2401 | 35p |
| 2N2412 | 27p |
| 2N2483 | 28p |
| 2N2904/5/6/7/7A | 10p |
| 2N3053 | 16p |
| 2N3055 R.C.A. | 60p |
| 2N3133/4062 | 24p |
| 2N3553 | 56p |
| 2N4037 | 39p |
| 2N5484 FET | 37p |
| 2N5956 | 87p |
| 40250(2N3054) | 35p |

### BRIDGE RECTIFIERS

| Amp | Volt | | |
|---|---|---|---|
| 1 | 1,600 | BYX10 | 34p |
| ¾ | 140 | OSH01-200 | 30p |
| 5 | 100 | Ex Equip | 73p |
| 0.6 | 110 | EC433 | 20p |
| 5 | 400 | Texas | £1.10 |
| 2½ | 100 | I.R. | 48p |
| 3½ | 100 | B40C 3200 | 58p |

### OTHER DIODES

| | |
|---|---|
| 1N916 | 4p |
| 1N4009 | 9p |
| 1N4148 | 1½p |
| BA145 | 17p |
| Centercel | 29p |
| BZY61/8A148/OA81 | 12p |
| BB103/110 Varicap | 24p |
| BB113 Triple Varicap | 43p |
| BA182 | 15p |
| OA5/7/10 | 17p |
| BZY88 up to 43 volt | 7½p |
| BZX61 11 volt | 17p |
| AA133 | 10p |
| BZY96C 10V | 34p |
| BZY95C 33V or 15V | 34p |

### CATALOGUE

38, 11 x 8 ins illustrated sheets, listing approx. 5,250 items, photo printed on day requested, from constantly updated masters, to ensure latest stock position. 75p (refundable with orders) plus 26p s.a.e. or label.

RS *Irravin* high temperature wire, 19/0.16, minus 55° to 105°C, 600V 3A, white, black or red. Half trade price at 54p 10M coil.

### PVC QUALITY TAPE

Lasso 10m x 15mm grey 38p
33m x 33mm green £1.13p

### TRANSFORMERS

Ferromag C core. Screens 95-105-115-125-200-220-240v input output 17v ¾A x 2 + 24-0-24v 1.04A+20v 1mA. These current ratings can be safely exceeded by 50%. £6.00

Cassette Dynamic Microphone with switch and twin plug £1.80

Telephone Pickup, sucker with lead and 3.5 plug 70p

Trimmer: Post stamp type 3-30pF 16p
10-80pF 19p
30-140pF ... 23p

### GARRARD

GCS23T Crystal Stereo Cartridge £1.20
Mono (Stereo compatible) Ceramic or crystal £1

### RECTIFIERS

| | Amp | Volt | |
|---|---|---|---|
| M1 | ½ | 68 | 5p |
| IN4004/5/6 | 1 | 4/6/800 | 6p |
| 1N4007/BYX94 | 1 | 1250 | 8p |
| BY103 | 1 | 1,500 | 21p |
| SR100 | 1.5 | 100 | 9p |
| SR400 | 1.5 | 400 | 10p |
| REC53A | 1.5 | 1,250 | 16p |
| LT102 | 2 | 30 | 15p |
| BYX22-200 | 1½ | 300 | 25p |
| BYX38-300R | 2.5 | 300 | 48p |
| BYX38-600 | 2.5 | 600 | 52p |
| BYX38-900 | 2.5 | 900 | 60p |
| BYX38-1200 | 2.5 | 1,200 | 65p |
| BYX49-300R | 3 | 300 | 35p |
| BYX49-600 | 3 | 600 | 42p |
| BYX49-900 | 3 | 900 | 47p |
| BYX49-1200 | 3 | 1,200 | 60p |
| BYX48-300R | 6 | 300 | 47p |
| BYX48-600 | 6 | 600 | 60p |
| BYX48-900 | 6 | 900 | 70p |
| BYX48-1200R | 6 | 1,200 | 92p |
| BYX72-150R | 10 | 150 | 42p |
| BYX72-300R | 10 | 300 | 52p |
| BYX72-500R | 10 | 500 | 65p |
| BYX42-300 | 10 | 300 | 36p |
| 1N5401 | 3 | 100 | 13p |
| 1N5402 | 3 | 200 | 15p |
| MR856 | 3 | 600 | 24p |
| BYX42-900 | 10 | 900 | 92p |
| BYX42-1200 | 10 | 1,200 | £1.07 |
| BYX46-300R* | 15 | 300 | £1.19 |
| BYX46-400R* | 15 | 400 | £1.75 |
| BYX46-500R* | 15 | 500 | £2.00 |
| BYX46-600* | 15 | 600 | £2.30 |
| BYX20-200 | 25 | 200 | 72p |
| BYX52-300 | 40 | 300 | £2.05 |
| BYX52-1200 | 40 | 1,200 | £2.90 |
| RAS310AF* | 1.25 | 1,250 | 48p |

**Avalanche type*

### OPTO ELECTRONICS

Diodes

| | |
|---|---|
| BPX40 | 57p |
| BPX42 | 92p |
| BPY10 | 92p |

(VOLTIAC)
BPY68
BPY69 ... 92p
BPY77
Wire end neons 4p

Photo transistor

| | |
|---|---|
| BPX29 | 92p |
| OCP71 | 40p |

### L.E.D.'s

.2" Red 9p
TIL209 .125" Red 14p
Green 16p
2" clip 2p

### PHOTO SILICON CONTROLLED SWITCH

BPX66 PNPN 10 amp ...... £1.15

.3" red 7 segment L.E.D. 14 D.I.L. 0-9+D.P. display 1.9v 19m/a segment, common anode ........ 95p
HP .43 in yellow £1.50
RS 0.6in. green .... £2.25
Minitron 0.3in 3015F filament ........ £1.25

CQY11B L.E.D.
Infra red transmitter .. £1.15
H15B Photon coupled isolator I.R. diode & NPN Photo-Darlington amp £1.05
Data Sheet 10p

### THYRISTORS

| Amp | Volt | | |
|---|---|---|---|
| | .40 | BTX18-200 | .35p |
| | 400 | BTX18-300 | .41p |
| | 240 | BTX30-200 | .35p |
| 4 | 500 | 40506 | .80p |
| 15 | 500 | BT107 | £1.00 |
| 6.5 | 500 | BT109-500R/SCR957/BRC4444 | £1.14 |
| 20 | 600 | BTW92-600RM | £3.40 |
| 15 | 800 | BTX95-800R Pulse Modulated | £8.75 |

### PAPER BLOCK CONDENSER

| | | |
|---|---|---|
| 0.25MFD | 800 volt | 87p |
| 1MFD | 250 volt | 54p |
| 1MFD | 400 volt | 65p |

### TV KNOB

Dark grey plastic for recessed shaft (quarter inch) with free shaft extension 8p

### CHASSIS SOCKETS

Car Aerial 11p, Coax 8p, 5 pin 180° 11p, 5 or 6 pin 240° din 8p, speaker din switched 13p, 3.5 mm switched 7p, stereo ¼" jack enclosed 20p.

### INTEGRATED CIRCUITS

| | |
|---|---|
| TBA920 TCA270 | £2.00 |
| TAA700 | £2.40 |
| TBA800/810 | 70p |
| 741/7490/7473 | 25p |
| uA702/LM3900 | 53p |
| 709/741 | 15p |
| 74107/74122 | 16p |
| SN76228N | £2.03 |
| SN76131/75110 | £1.55 |
| SN76013N/ND | £1.40 |
| TAD100 AMRF | £1.22 |
| CA3001 R.F. Amp | £1.58 |
| CA3132 | £2.22 |
| 74151 | 32p |
| CD4069 | 15p |
| TAA300 1 wt Amp | £1.00 |
| TAA550 Y or G | 28p |
| TAA263/74LS192 | 70p |
| TAA320 | £1.15 |
| 7400/01/06 | 15p |
| 7402/4/10/20/30 | 15p |
| 7414/7413N | 44p |
| 7438/26/32/37 | 15p |
| AY5 8300 | £1.00 |
| 7483/ZN414 | 79p |
| CD4013/19 | 28p |
| LM3002/20V reg | £1.15 |
| LM1303N | £1.00 |
| CD4040 | 50p |
| TBA5500/74S112 | £1.80 |
| 74154 | 35p |

### HANDLES

Rigid light blue nylon 6¼" with secret fitting screws 11p

Belling Lee white plastic surface coax outlet box 40p

Miniature Axial Lead Ferrite Choke formers 5 for 13p

RS 10 Turn pot 1% 250 500 Ω 1K. £1.70

Copper coated board 18¼" x 2¼" 40p

Geared Knob 8-1 ratio. 1¼" diam., black 93p

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Professional leaf spring clamp, twin with clip-over cover 11p
Strip of 4, 40A 440V 16p

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3 inch 8 Ω speaker ........ £1.15

### September Offers

SN15809310 for £2.50
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74LS192 10 for £4.00
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RS Battery Holder, takes 4HP 11s, 4 for £1.00
1 kilogram mixed bolts, nuts, washers etc. £2.50

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Nixi Tubes 60p
30pF Beehive Trimmer 10p

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| | | | |
|---|---|---|---|
| ACY17-20 | 10p | TIC44 | 17p |
| ASZ20 | 10p | 2G240 | £1.17 |
| ASZ21 | 35p | 2G302 | 6p |
| | | 2G401 | 6p |
| BC186 | 13p | 2N711 | 28p |
| BCY30-34 | 24p | 2N2926 | 6p |
| BCY70/1/2 | 10p | 2N598/9 | 8p |
| BY126/7 | 5p | 2N1091 | 10p |
| HG1005 | 12p | 2N1302 | 10p |
| HG5009 | 4p | 1N1907 | £1.17 |
| HG5079 | 4p | Germ. diode | 2p |
| L78/9 | 4p | 2N3055 | |
| M3 | 12p | Motorola | 36p |
| OA81 | 4p | GET120 (AC128 in 1" sq. heat sink | 22p |
| OA47 | 4p | | |
| OA200-2 | 4p | | |
| OC23 | 27p | GET872 | 15p |
| OC200-5 | 24p | 2S3230 | 34p |
| C106 THY | 28p | TIS43 | 15p |

### MINIATURE EDGE METERS

100uA f.s.d., scaled 0.5. 12V Illuminated blue perspex front 35mm x 14mm £3.45

200uA level meter, clear front. 10 x 18mm £1.20

### TRIACS

| Amp | Volt | | |
|---|---|---|---|
| 25 | 900 | BTX94-900 | £3.00 |
| 25 | 1200 | BTX94-1200 | £5.00 |

Diode Characteristic, Equiv., and Substitution Book 82p
Transistor equivalents and substitution Book 1 38p Book 2 82p
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Mullard Semiconductor, Valve & Component Data Book 1976-78 . 50p

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# STEVENSON
## Electronic Components

## TTL

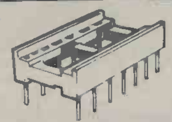
| | | | | | |
|---|---|---|---|---|---|
| | | 7473 | 20p | 74141 | 55p |
| | | 7474 | 22p | 74145 | 55p |
| 7400 | 10p | 7475 | 25p | 74148 | 90p |
| 7401 | 10p | 7476 | 20p | 74150 | 55p |
| 7402 | 10p | 7485 | 55p | 74151 | 40p |
| 7404 | 12p | 7486 | 20p | 74154 | 65p |
| 7406 | 22p | 7489 | 135p | 74157 | 40p |
| 7408 | 12p | 7490 | 25p | 74164 | 55p |
| 7410 | 10p | 7492 | 30p | 74165 | 55p |
| 7413 | 22p | 7493 | 25p | 74170 | 100p |
| 7414 | 39p | 7494 | 45p | 74174 | 55p |
| 7420 | 12p | 7495 | 35p | 74177 | 50p |
| 7427 | 20p | 7496 | 45p | 74190 | 50p |
| 7430 | 12p | 74121 | 25p | 74191 | 50p |
| 7432 | 18p | 74122 | 35p | 74192 | 50p |
| 7442 | 38p | 74123 | 38p | 74193 | 50p |
| 7447 | 45p | 74125 | 35p | 74196 | 50p |
| 7448 | 50p | 74126 | 35p | 74197 | 50p |
| 7454 | 12p | 74132 | 45p | 74199 | 90p |

## CMOS

| | | | | | |
|---|---|---|---|---|---|
| | | 4020 | 50p | 4050 | 25p |
| | | 4022 | 50p | 4060 | 80p |
| | | 4023 | 13p | 4066 | 30p |
| | | 4024 | 40p | 4068 | 13p |
| 4001 | 13p | 4025 | 13p | 4069 | 13p |
| 4002 | 13p | 4026 | 90p | 4070 | 13p |
| 4007 | 13p | 4027 | 28p | 4071 | 13p |
| 4009 | 30p | 4028 | 45p | 4072 | 13p |
| 4011 | 13p | 4029 | 50p | 4081 | 13p |
| 4012 | 13p | 4040 | 55p | 4093 | 36p |
| 4013 | 28p | 4041 | 55p | 4510 | 60p |
| 4015 | 50p | 4042 | 55p | 4511 | 60p |
| 4016 | 28p | 4043 | 50p | 4518 | 65p |
| 4017 | 47p | 4046 | 90p | 4520 | 60p |
| 4018 | 55p | 4049 | 25p | 4528 | 60p |

FULL DETAILS IN CATALOGUE!

## SKTS



Low profile by Texas

| | | | | | |
|---|---|---|---|---|---|
| 8pin | 8p | 18pin | 14p | 24pin | 18p |
| 14pin | 10p | 20pin | 16p | 28pin | 22p |
| 16pin | 11p | 22pin | 17p | 40pin | 32p |

Soldercon pins: 100:50p 1000:370p

## PCBS

VEROBOARD

| Size in. | 0.1in. | 0.15in. | |
|---|---|---|---|
| 25 x 1 | 14p | 14p | Vero Cutter 80p. |
| 2.5 x 3.75 | 45p | 45p | |
| 2.5 x 5 | 54p | 54p | Pin insertion tool 108p |
| 3.75 x 5 | 64p | 64p | |
| 3.75 x 17 | 205p | 185p | |
| Single sided pins per 100 | 40p | 40p | |

Top quality fibre glass copper board. Single sided. Size 203 x 95mm. 60p each.
'Dalo' pens. 75p each.
Five mixed sheets of Alfac. 145p per pack.

## OPTO

| LED's | 0.125in. | 0.2in | each | 100+ |
|---|---|---|---|---|
| Red | TIL209 | TIL220 | 9p | 7.5p |
| Green | TIL211 | TIL221 | 13p | 12p |
| Yellow | TIL213 | TIL223 | 13p | 12p |
| Clips | 3p | 3p | | |

DISPLAYS

| | | | |
|---|---|---|---|
| DL704 | 0.3 in CC | 130p | 120p |
| DL707 | 0.3 in CA | 130p | 120p |
| FND500 | 0.5 in CC | 100p | 80p |

## RESISTORS

Carbon film resistors. High stability, low noise 5%.
E12 series. 4.7 ohms to 10M. Any mix:

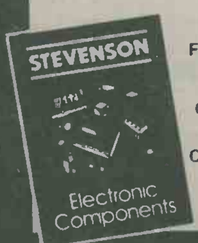
| | each | 100+ | 1000+ |
|---|---|---|---|
| 0.25W | 1p | 0.9p | 0.8p |
| 0.5W | 1.5p | 1.2p | 1p |

Special development packs consisting of 10 of each value from 4.7 ohms to 1 Megohm (650 res) 0.5W £7.50. 0.25W £5.70.

METAL FILM RESISTORS

Very high stability, low noise rated at ¼W 1%. Available from 51ohms to 330k in E24 series. Any mix:

| | each | 100+ | 1000+ |
|---|---|---|---|
| 0.25W | 4p | 3.5p | 3.2p |

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## TRANSISTORS

| | | | | | |
|---|---|---|---|---|---|
| AC127 | 17p | BCY72 | 14p | ZTX500 | 16p |
| AC128 | 16p | BD131 | 35p | 2N697 | 12p |
| AC176 | 18p | BD132 | 35p | 2N3053 | 18p |
| AD161 | 38p | BD139 | 35p | 2N3054 | 50p |
| AD162 | 38p | BD140 | 35p | 2N3055 | 50p |
| BC107 | 8p | BFY50 | 15p | 2N3442 | 135p |
| BC108 | 8p | BFY51 | 15p | 2N3702 | 8p |
| BC108C | 10p | BFY52 | 15p | 2N3703 | 8p |
| BC109 | 8p | MJ2955 | 98p | 2N3704 | 8p |
| BC109C | 10p | MPSA06 | 20p | 2N3705 | 9p |
| BC147 | 7p | MPSA56 | 20p | 2N3706 | 9p |
| BC148 | 7p | TIP29C | 60p | 2N3707 | 9p |
| BC177 | 14p | TIP30C | 70p | 2N3708 | 8p |
| BC178 | 14p | TIP31C | 65p | 2N3819 | 15p |
| BC179 | 14p | TIP32C | 80p | 2N3820 | 44p |
| BC182 | 10p | TIP2955 | 65p | 2N3904 | 8p |
| BC182L | 10p | TIP3055 | 55p | 2N3905 | 8p |
| BC184 | 10p | ZTX107 | 14p | 2N3906 | 8p |
| BC184L | 10p | ZTX108 | 14p | 2N4058 | 12p |
| BC212 | 10p | ZTX300 | 16p | 2N5457 | 32p |
| BC212L | 10p | | | 2N5459 | 32p |
| BC214 | 10p | | | 2N5777 | 50p |
| BC214L | 10p | | | | |
| BC477 | 19p | | | | |
| BC478 | 19p | | | | |
| BC548 | 10p | | | | |
| BCY70 | 14p | | | | |
| BCY71 | 14p | | | | |

### DIODES

| | | | |
|---|---|---|---|
| 1N914 | 3p | 1N4006 | 6p |
| 1N4001 | 4p | 1N5401 | 13p |
| 1N4002 | 4p | BZY88 ser | 8p |

ITT Full spec. product.
1N4148 £1.40/100. £11/1000

## LINEAR

THIS IS ONLY A SELECTION!

| | | | | | |
|---|---|---|---|---|---|
| | | LF356 | 80p | NE531 | 98p |
| | | LM301AN | 26p | NE555 | 23p |
| | | LM308 | 60p | NE556 | 60p |
| | | LM318N | 75p | NE567 | 100p |
| | | LM324 | 45p | RC4136 | 100p |
| 709 | 35p | LM339 | 45p | SN76477 | 230p |
| 741 | 16p | LM378 | 230p | TBA800 | 70p |
| 747 | 45p | LM379S | 410p | TBA810S | 100p |
| 748 | 30p | LM380 | 75p | TDA1022 | 620p |
| 7106 | 850p | LM3900 | 50p | TL081 | 45p |
| 7107 | 900p | LM3909 | 65p | TL084 | 125p |
| CA3046 | 55p | LM3911 | 100p | ZN414 | 80p |
| CA3080 | 70p | MC1458 | 32p | ZN425E | 390p |
| CA3130 | 90p | MM57160 | 590p | ZN1034E | 200p |

## CAPACITORS

TANTALUM BEAD (each)
0.1, 0.15, 0.22, 0.33, 0.47, 0.68, 1 & 2.2uF @ 35V . . . 8p
4.7, 6.8, 10uF @ 25V . . . 13p
22 @ 16V, 47 @ 6V, 100 @ 3V . . . 16p

MYLAR FILM
0.001, 0.01, 0.022, 0.033, 0.047 . . . 3p
0.068, 0.1 . . . 4p

POLYESTER
Mullard C280 series
0.01, 0.015, 0.022, 0.033, 0.047, 0.068, 0.1. 5p
0.15, 0.22 . . . 7p
0.33, 0.47 . . . 10p
0.68 . . . 14p
1.0uF . . . 17p

CERAMIC
Plate type 50V. Available in E12 series from 22pF to 1000pF and E6 series from 1500pF to 0.047uF . . . 2p

RADIAL LEAD ELECTROLYTIC

| | | | | | | |
|---|---|---|---|---|---|---|
| 63V | 0.47 | 1.0 | 2.2 | 4.7 | 10 | 5p |
| | | | 22 | 33 | 47 | 7p |
| | 100 | | | | | 13p |
| | | | 220 | | | 20p |
| 25V | 10 | 22 | 33 | 47 | | 5p |
| | 100 | | | | | 8p |
| | | 220 | | | | 10p |
| | | | | 470 | | 15p |
| | 1000 | | | | | 23p |

## CONNECTORS

JACK PLUGS AND SOCKETS

| | screened | unscreened | socket |
|---|---|---|---|
| 2.5mm | 9p | 13p | 7p |
| 3.5mm | 9p | 14p | 8p |
| Standard | 16p | 30p | 15p |
| Stereo | 23p | 36p | 18p |

DIN PLUGS AND SOCKETS

| | plug | chassis socket | line socket |
|---|---|---|---|
| 2pin | 7p | 7p | 7p |
| 3pin | 11p | 9p | 14p |
| 5pin 180° | 11p | 10p | 14p |
| 5pin 240° | 13p | 10p | 16p |

1mm PLUGS AND SOCKETS
Suitable for low voltage circuits. Red & black.
Plugs: 6p each  Sockets: 7p each.

4mm PLUGS AND SOCKETS
Available in blue, black, green, brown, red, white and yellow. Plugs: 11p each  Sockets: 12p each

PHONO PLUGS AND SOCKETS
Insulated plug in red or black . . . 9p
Screened plug . . . 13p
Single socket . 7p  Double socket . 10p

## LOUDSPEAKERS

56mm dia. 8ohms. 70p  64mm dia. 64ohms. 75p
64mm dia. 8ohms. 75p  70mm dia. 8ohms. 100p
Magnetic earpiece including 2.5 or 3.5mm plug. 15p each
Crystal earpiece including 3.5mm plug. 30p each

## TRANSFORMERS

All 240V Primary.

| | |
|---|---|
| 0 – 6, 0 – 6 @ 0.5A or 0 – 9, 0 – 9 @ 0.4A. | 175p |
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| 0 – 9, 0 – 9 @ 1.2A or 0 – 12, 0 – 12 @ 1A. | 345p |
| 0 – 12 – 15 – 20 – 24 – 30V @ 1.5A. | 455p |
| 0 – 20 – 25 – 33 – 40 – 50V @ 1A. | 455p |
| 0 – 20 – 25 – 33 – 40 – 50V @ 2A. | 585p |
| 0 – 20 – 25 – 33 – 40 – 50V @ 3A. | 715p |
| Miniature type 6 – 0 – 6, 9 – 0 – 9, 12 – 0 – 12 @ 100mA. | 95p |

## SOLDERING IRONS

ANTEX X25 (25W) or ANTEX CX (17W) 390p each
Reel of solder (39.6M) 240p each

## POTENTIOMETERS

Single gang Log or Lin 5K – 2M2 28p each
Dual gang Log or Lin 5K – 2M2 80p each
Presets, sub min. type hor. or vert. 100Ω – 2M2 6p each

## CONTROL KNOBS

Ideal for use on mixers etc. Push on type with black base and marked position line. Cap available in red, blue, green, grey, yellow and black. 14p

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Subminiature toggle. SPDT 70p. DPDT 80p.
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Slide switches (DPDT) miniature or standard 15p.
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Wavechange switches: 1P12W, 2P6W, 3P4W, 4P3W. 43p

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Folded construction complete with screws.

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|---|---|---|---|---|---|
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| 4 x 3 x 2 | 64p | 6 x 4 x 2 | 77p | 8 x 6 x 2 | 125p |

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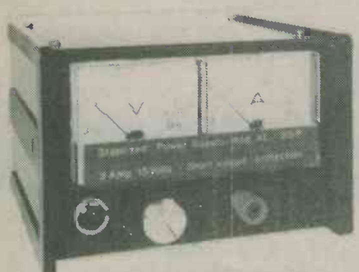
| | |
|---|---|
| INPUT VOLTAGE | 220 V ac ± 10% 50-60 Hz |
| OUTPUT VOLTAGE RANGE | 12,6 V dc |
| OUTPUT CURRENT MAX | 2,5 Amp |
| LOAD REGULATION | <0,3% 0÷2,2 Amp |
| RIPPLE | <5mV 2,2 Amp |
| DIMENSIONS (mm) | W140 × H90 × D140 |
| WEIGHT | 1,490 Kg. |

## AL.315 P



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| | |
|---|---|
| INPUT VOLTAGE | 220 V ac ± 10% 50-60 Hz |
| OUTPUT VOLTAGE RANGE | 1,7÷15 V. dc |
| LOAD REGULATION | <0,2% 0-2,8 Amp |
| DIMENSIONS (mm) | W140 × H90 × D155 |
| RIPPLE | 3mV 2,8 Amp |
| WEIGHT | 2,330 Kg. |

## AL.330 P

**£46.50**

| | |
|---|---|
| INPUT VOLTAGE | 220 V ac ± 10% 50-60 Hz |
| OUTPUT VOLTAGE RANGE | 3,4÷30 V. dc |
| OUTPUT CURRENT RANGE MAX | 3 Amp |
| LOAD REGULATION | < 5% 0-2.8 Amp |
| RIPPLE | 10mV 2,8 Amp |
| DIMENSIONS (mm) | W270 × H90 × D155 |
| WEIGHT | 4,250 Kg. |

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## AL.1 P5

**£78.00**

| | |
|---|---|
| INPUT VOLTAGE | 220 ± 10% 50 Hz |
| OUTPUT VOLTAGE RANGE | 1 ± 15 V. dc |
| OUTPUT CURRENT MAX | 5 Amp |
| LOAD REGULATION | < 0,1% 0-45 Amp |
| RIPPLE | < 2mV 4,5 Amp |
| DIMENSIONS (mm) | W210 × H155 × D250 |
| WEIGHT | 5,100 Kg. |

## AL.212 PS

**£18.00**

| | |
|---|---|
| INPUT VOLTAGE | 220 V ac ± 10% 50-60 Hz |
| OUTPUT VOLTAGE RANGE | 12,6 V dc |
| OUTPUT CURRENT MAX | 2,5 Amp |
| LOAD REGULATION | <0,3% 0÷2,2 Amp |
| RIPPLE | <5mV 2,2 Amp |
| DIMENSIONS (mm) | W140 × H90 × D140 |
| WEIGHT | 1,490 Kg. |
| AMPEROMETER | |

## AL.315 P2

**£54.00**

| | |
|---|---|
| INPUT VOLTAGE | 220 V ac ± 10% 50-60 Hz |
| OUTPUT VOLTAGE RANGE | ± 1,7 ± 15 V dc |
| OUTPUT CURRENT RANGE MAX | 3 Amp |
| LOAD REGULATION | < 0,2% 0-2,8 Amp |
| RIPPLE | < 3mV 2,8 Amp |
| DIMENSIONS (mm) | W270 × H90 × D155 |
| WEIGHT | 4,140 Kg. |

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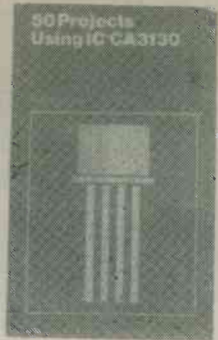


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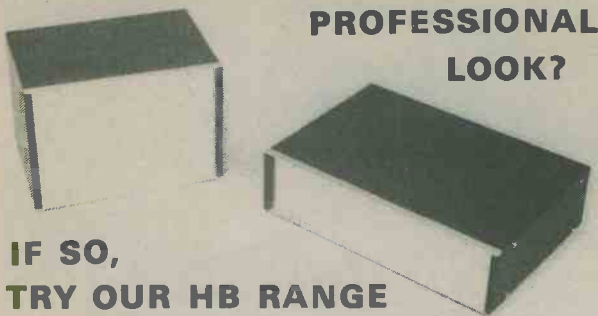

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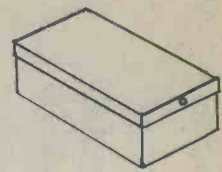

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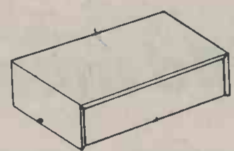

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| 100/10v | 5p | 33/63v | 5p |
| 100/16v | 6p | 47/16v | 5p |
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| 330/25 | 8p | 220/16v | 6p |
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| 470/16v | 8p | 330/25v | 8p |
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# STYLUS ORGAN

By M. V. Hastings

## *Easy to build monophonic electronic organ with switchable vibrato*

A modern polyphonic electronic organ is quite a complex and expensive piece of equipment, even when special organ i.c.'s are incorporated in the design. However, a simple monophonic instrument which plays only one note at a time can provide many hours of enjoyment, and its construction is considerably eased if it is stylus operated. The design to be described covers the two octaves above Middle C or, if preferred, an octave either side of Middle C. It is completely self-contained and has an integral vibrato circuit which can be switched in or out as desired.

A further facility is the provision of two jack sockets, one coupling to the output of the tone generator and the other to the input of the organ a.f. amplifier. An external envelope shaper can be connected to these sockets to process the signal before it is passed to the a.f. amplifier. An envelope shaper, specifically designed for use with the present organ, will be described in next month's issue. The socket connecting to the output of the tone generator will also take the plug of a crystal earpiece, thereby providing personal listening for practice or simply enjoyment. Inserting the earpiece plug disconnects the tone generator from the a.f. amplifer in the organ.

### CIRCUIT DESIGN

The full circuit of the organ is shown in Fig. 1. A BRY39 silicon controlled switch (s.c.s.) connected to operate as a programmable unijunction transistor is connected in a relaxation oscillator circuit which generates the required note. This type of oscillator has been described previously in the article "Silicon Controlled Switch Circuits", Parts 1 and 2, by John Baker, which appeared in the December 1978 and January 1979 issues of *Radio & Electronics Constructor*, and so its functioning will only be described briefly here.

***An Envelope Shaper giving a varying amplitude characteristic to the output will be published next month***

The GK (gate cathode) terminal of the BRY39 is biased about 2.9 volts positive of the negative supply rail by R6 and R7, and the A (anode) terminal is taken to the positive rail via R8. No connection is made to the GA (gate anode) terminal. Initially, the K (cathode) terminal will be at the positive supply rail potential, since C6 will be discharged. Under these conditions, no current flows through the s.c.s. from anode to cathode. If the stylus connected to the negative rail is now applied to one of the pre-set potentiometers, R12 and R36, C6 commences to charge up by way of R9 and the potentiometer chosen. When C6 has charged to a voltage which causes the cathode of the s.c.s. to be about 0.6 volt negative of the GK terminal, a regenerative action suddenly takes place inside the s.c.s., causing it to turn hard on and quickly discharge C6 through its anode and cathode terminals and through R8. C6 becomes nearly fully discharged, and when the voltage across it becomes insufficient to maintain the s.c.s. in the hard on condition the latter rapidly reverts to the turned off state. C6 is once more free to charge and it does so until once more the s.c.s. turns hard on. The cycles proceed in like manner, a voltage pulse being produced across R8 for each discharge of C6.

The oscillations proceed at an audio frequency whose frequency is controlled by the pre-set potentiometer selected by the stylus, and the stream of pulses produced across R8 form the output signal. These are passed via R10 and d.c. blocking capacitor C7 to jack socket JK1. R10 and C8 attenuate some of the higher frequency harmonics in the signal, giving it a more musically pleasing tone. When no plugs are inserted in JK1 or JK2 the signal is automatically passed to the volume control, VR1, and the subsequent a.f. amplifier. If a jack plug connecting to a crystal earpiece is inserted in JK1 the connection to the volume control is broken and the signal is heard in the earpiece.

The operating frequency of the tone generator depends upon the resistance inserted into circuit by the pre-set potentiometer selected by the stylus, and in practice the 25 potentiometers are set up to provide a full 2-octave scale including semitones, one potentiometer being used to produce each note.

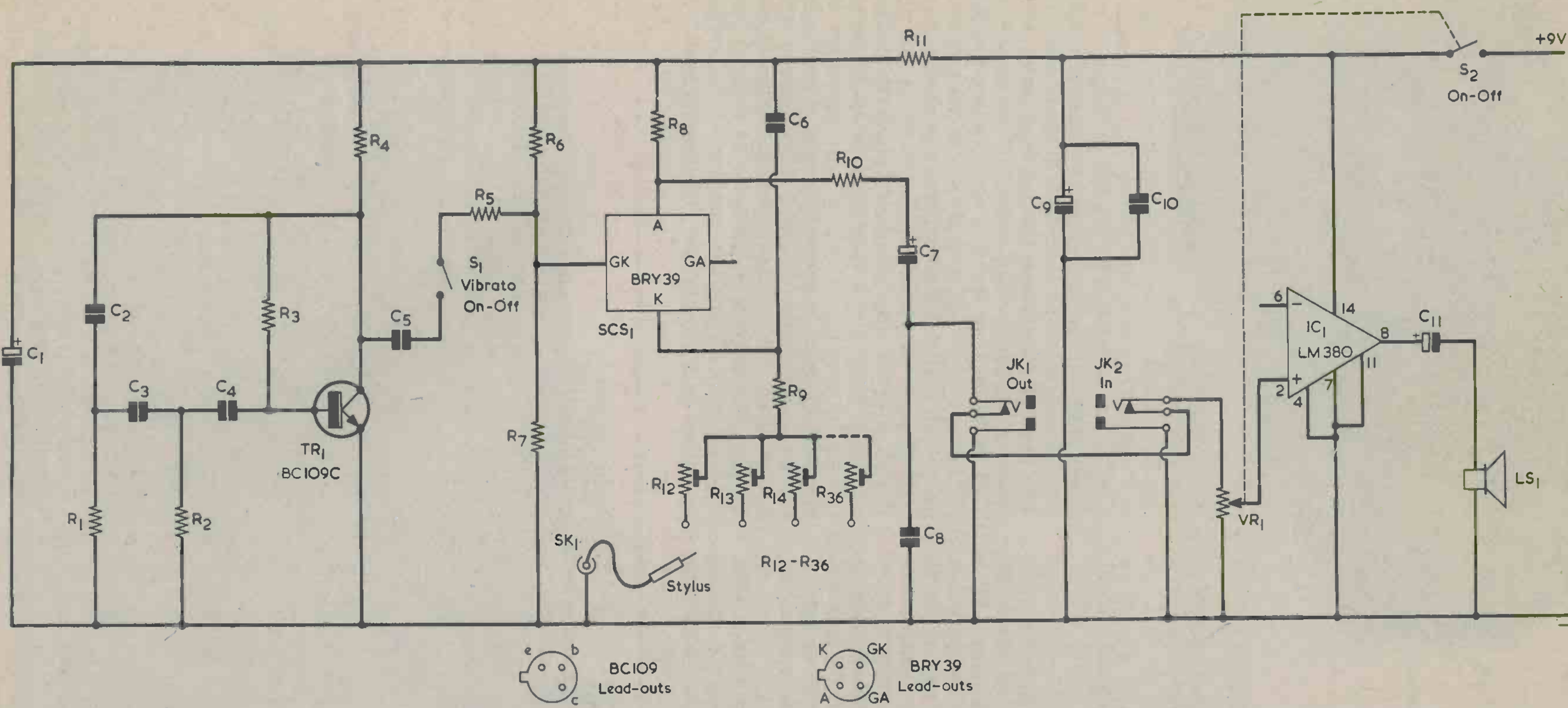
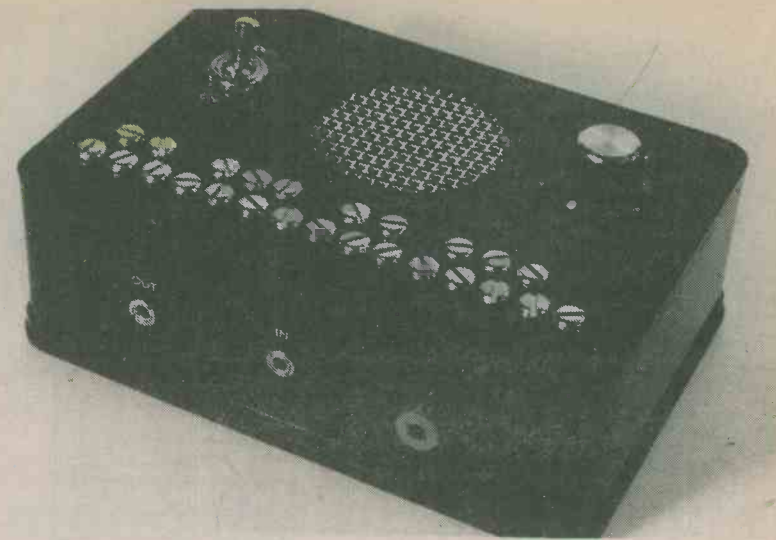



*Fig. 1. The circuit of the electronic organ. Each note is played by applying the tip of the stylus to the lower track connection of one of the pre-set potentiometers, R12 to R36. Vibrato can be switched in or out by means of S1*

Nickel plated screw heads form the keyboard of the organ. These are laid out, in a manner similar to a piano keyboard, to provide two octaves complete with semitones




## VIBRATO

A simple tone generator tends to produce a rather monotonous sound, and a much more pleasant and more musical effect can be given by modulating the tone at a low frequency. The modulation can be amplitude modulation (tremolo) in which the volume of the signal is changed, or it can be frequency modulation (vibrato) in which the pitch of the sound is slightly varied on either side of its nominal level. Vibrato offers what is probably the better effect, and frequency modulation is employed in this design.

A phase shift oscillator produces the modulating signal, and incorporates TR1 in the common emitter amplifying mode. A 3-stage phase shift network comprising C2, R1, C3, R2 and C4 couples TR1 collector back to its base, and the 180 degree phase shift between collector and base which is required for oscillation to occur is given at about 8Hz. The gain of TR1 more than compensates for the losses in the phase shift network. The output from TR1 collector is coupled to the junction of R6 and R7 by way of C5, S1 and R5. S1 is the vibrato on-off switch whilst R5 attenuates the modulation so that it is not excessive.

The effect of the modulating signal is to slightly raise and lower the voltage on the GK terminal of the silicon controlled switch. Raising this voltage reduces the voltage needed across C6 to trigger on the s.c.s., whereupon output frequency increases. Lowering the GK voltage makes it necessary for C6 to charge to a greater voltage and thereby lowers the frequency. Thus, the required vibrato effect is produced in a simple and reliable manner.

### COMPONENTS

*Resistors*
(All fixed values ¼ watt 5% unless otherwise stated)
R1 33kΩ
R2 33kΩ
R3 2.2MΩ 10%
R4 4.7kΩ
R5 220kΩ
R6 4.7kΩ
R7 2.2kΩ
R8 680 Ω
R9 5.6kΩ
R10 47kΩ
R11 680Ω
R12-R36 47kΩ 0.1 watt pre-set potentiometer, horizontal (25-off)
VR1 5kΩ potentiometer, log, with switch S2

*Capacitors*
C1 100μF electrolytic, 10V, Wkg.
C2 0.22μF type C280
C3 0.22μF type C280
C4 0.22μF type C280
C5 0.47μF type C280
C6 0.1μF type C280 (see text)
C7 10μF electrolytic, 10V. Wkg.
C8 2,200μF ceramic plate
C9 100μF electrolytic, 10V. Wkg.
C10 0.047μF ceramic or ceramic plate
C11 330μF electrolytic, 10V. Wkg.

*Semiconductors*
TR1 BC109C
IC1 LM380
SCS1 BRY39

*Switches*
S1 s.p.s.t. toggle
S2 s.p.s.t. toggle, part of VR1

*Sockets*
SK1 insulated wander plug socket
JK1 3.5mm jack socket with break contact
JK2 3.5 jack socket with break contact

*Speaker*
LS1 miniature speaker, 8Ω to 25Ω (see text)

*Miscellaneous*
Plastic case (see text)
Veroboard, 0.1in. matrix
9-volt battery type PP6
Battery connector
Control knob
Test prod, flexible lead and wander plug
Speaker cloth or fret
25-off 6mm. M4 nickel plated panel-head screws
25-off M4 nuts
25-off M4 (or 4BA) solder tags
Wire, nuts bolts, solder, etc.

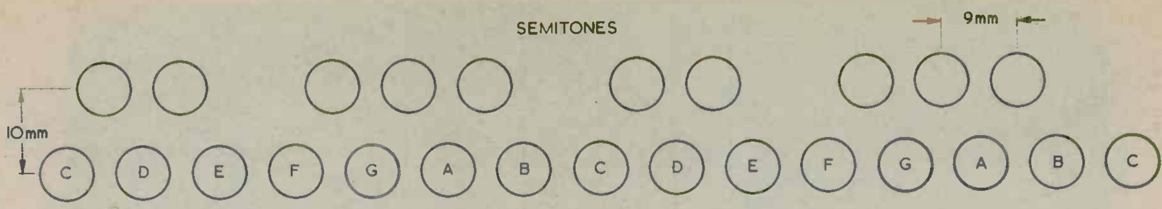



*Fig. 2. The organ keyboard consists of 25 nickle plated screw heads laid out in the manner shown here*

## AMPLIFIER

An LM380 i.c. forms the a.f. amplifier of the organ. The only discrete components required here are the volume control, VR1, and the output coupling capacitor, C11. An output power of the order of a few hundred milliwatts can be obtained using a speaker having an impedance in the range of 8Ω to 25Ω. The circuit will also work perfectly well with speakers having a higher impedance, but will then give reduced maximum output power.

We have already noted that a crystal earpiece can be plugged into JK1. If it is intended to use the special effects processor which will be described next month, the input of the processor is plugged into JK1 and its output is plugged into JK2. Fitting the plug into JK2 automatically isolates the socket from JK1.

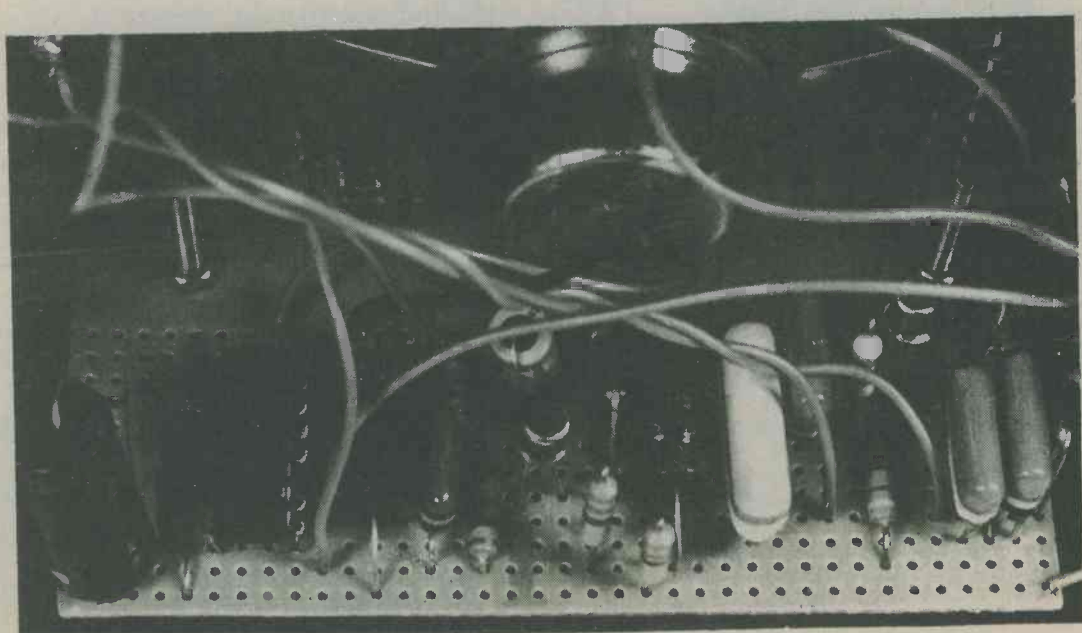
S2 is the on-off switch, and is ganged with the volume control. C1, C9, C10 and R11 are supply decoupling components. The current consumption of the organ is about 10mA at low volume settings, rising to 60mA or more at maximum volume on the higher notes.

## CONSTRUCTION

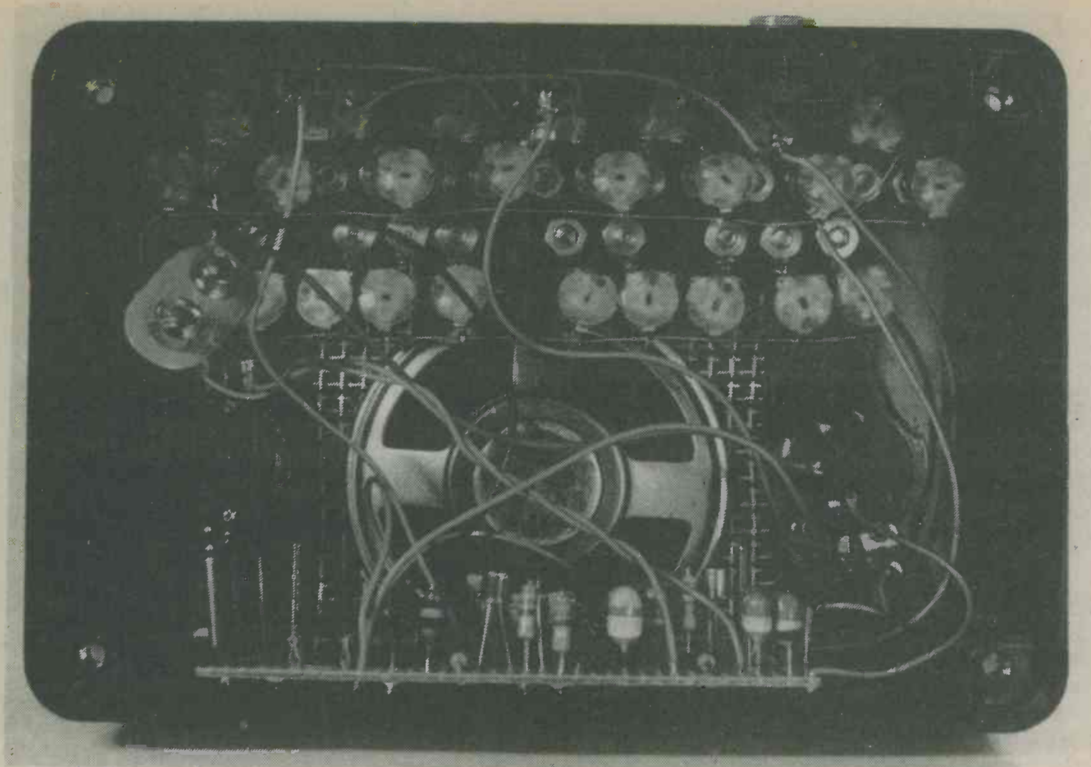
The prototype organ is housed in a black plastic case having approximate outside dimensions of 159 by 108 by 54mm. This is a case type MA1, available from Harrison Bros., P.O. Box 55, Westcliffe-on-Sea, Essex, SS0 7LQ.

The organ keyboard could be made up using printed circuit board techniques, but the simple alternative employed for the prototype is easier to construct and is very effective in practice. It consists of 25 nickel plated 6mm. panel-head M4 screws mounted on the top panel of the case towards the front and laid out in the form of a piano keyboard, as shown in Fig.2 and the photographs. The mounting holes at 4.5mm. in diameter, and a solder tag is secured inside the case, under the nut for each screw. M4 solder tags do not appear to be readily available, but 4BA solder tags will be a satisfactory substitute.

A circular cut-out for the speaker is required centrally in the top panel towards the rear, and this can be made with a fretsaw or a round needle file. A piece of speaker cloth or fret is glued in position



*Nearly all the small components are wired up on a Veroboard panel which is secured to the inside of the rear panel of the case*



*The interior of the organ. One pre-set potentiometer has a track tag soldered to each of the keyboard screw solder tags*

behind the cut-out. Most miniature speakers do not have provision for screw fixing, and so it will be necessary to carefully glue the speaker in place behind the cloth or fret. A minimal amount of glue should be applied to the front rim of the speaker. Avoid getting any glue on the speaker cone or surround as this could impair the performance of the speaker.

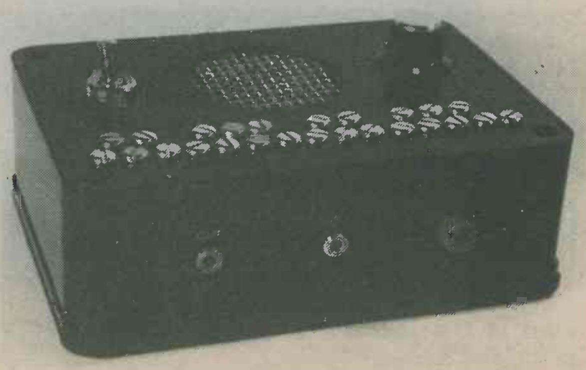
VR1/S2 is mounted to the right of the speaker and S1 to the left. JK1 is mounted on the left hand side of the front panel (looking at the organ from the front) JK2 in the centre and SK1 to the right.

The 25 pre-set potentiometers are mounted on the Keyboard solder tags (one potentiometer to each tag, of course) by one of the track connection tags. The wiper connection tags are wired together by bare tinned copper wires of around 22s.w.g. in size. Three bus-bar wires connect to R9. The photograph of the interior of the organ gives an idea of the positioning of the potentiometers. The job of mounting the potentiometers is rather fiddly but not too difficult, and the mounting of each potentiometer to its own screw has the advantage of making the identification of the potentiometer for each note readily apparent.

The stylus can be a test prod connected by a flexible insulated lead to a wander plug, which plugs into SE1 when the organ is being used.

## CIRCUIT BOARD

The remaining small components are assembled on a piece of 0.1in. Veroboard having 15 copper strips by 37 holes. This is illustrated in Fig. 3. Start by cutting out a board of the required size with a hacksaw, then smooth off any rough edges with a file. Next drill out the two mounting holes, which may be either 6BA or M3 clear, then make the 16 breaks in the copper strips. The various components and the three link wires can then all be



*The speaker is mounted centrally behind the keyboard screws, with the vibrato switch to its left and the volume control to its right*

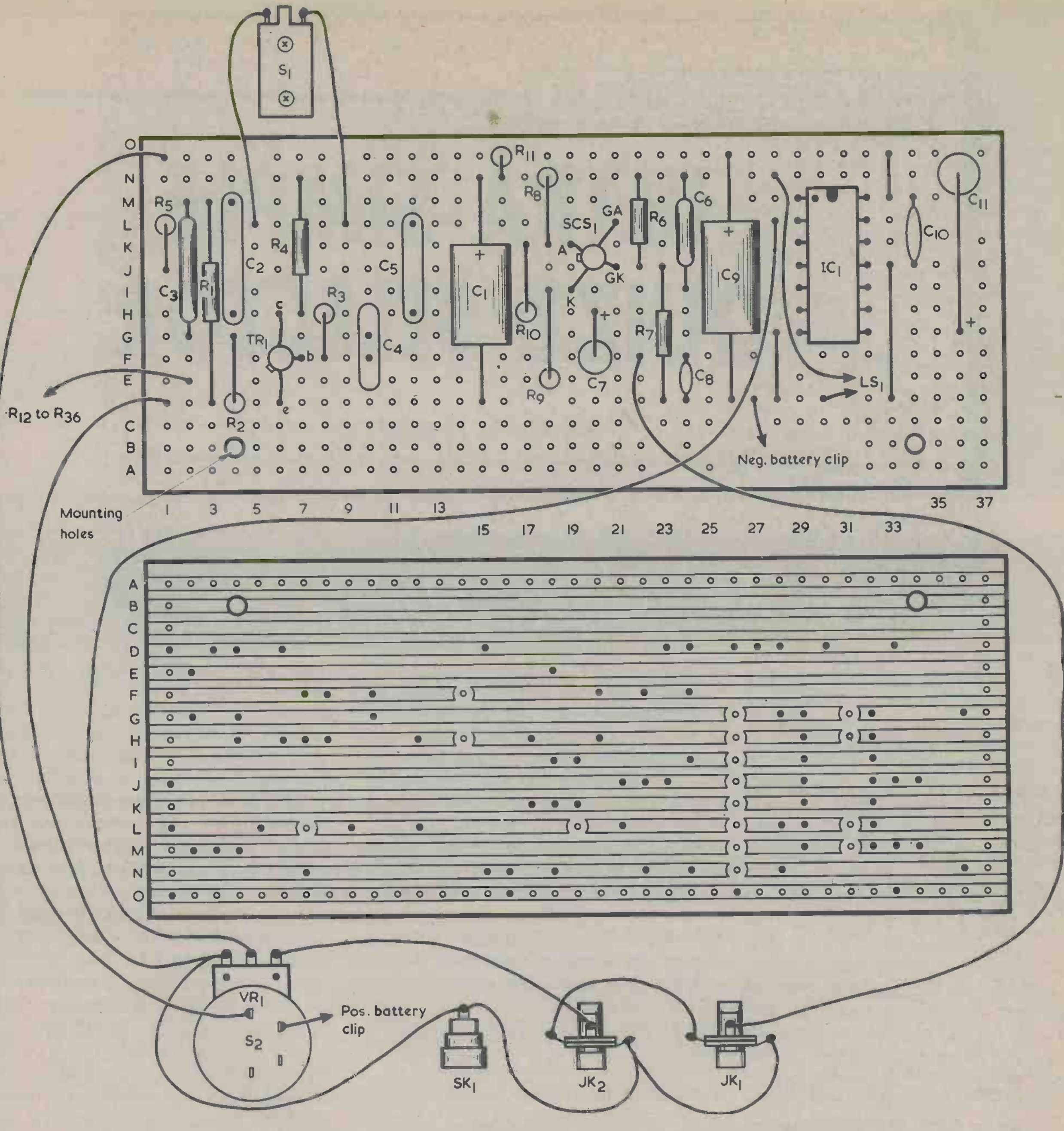



*Fig. 3. Layout of components on the Verboard panel and connections to the components external to the panel*

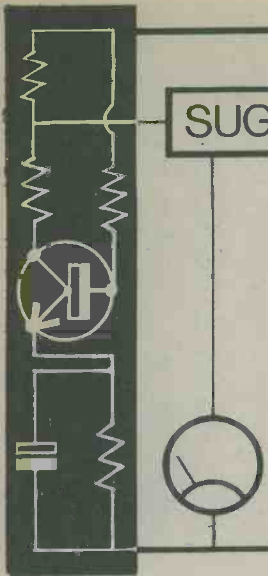
soldered into position. It is only necessary to connect the negative supply rail to pins 4 and 11 of the LM380, as the remaining ground pins, 3, 6, 10 and 12 are internally connected to these inside the i.c.

The completed panel is bolted inside the rear panel of the case, with the mounting holes towards the top. Spacing washers over the mounting bolts between the Veroboard and the inside surface of the case are fitted to prevent strain on the board when the mounting nuts are tightened. The wiring from the board to the external components, also shown in Fig.3, must be completed before the board is finally mounted in place. The organ is powered by a PP6 battery, and there is plenty of space for this below the keyboard.

## TUNING

The organ is tuned aurally against a piano or other source of a chromatic scale and, with the component values specified, will tune from Middle C to the C two octaves higher. If preferred, the organ can be given a tuning range of one octave either side of Middle C by increasing the value of C6 to 0.22$u$F. The tuning is largely unaffected by variations in the supply voltage due to battery aging, and once correctly tuned will remain so for a considerable period of time.

An envelope shaper which can be coupled to the organ will be described next month.



## SUGGESTED CIRCUIT

# ULTRA-SIMPLE QUIZZ SELECTOR

**By G. A. French**

We are all familiar with broadcast quiz programmes in which each of two contestants has to press a button to indicate that he is ready to answer a question. The quizmaster is provided with two lights to indicate which of the buttons has been pressed first, and these lights function even when one button is pressed only marginally ahead of the other.

A number of circuits which indicate button precedence have appeared in the home-constructor press over recent years, some of these being relatively uncomplicated and others quite complex. The author returns to the theme in the present article only because the circuit to be described is possibly the simplest which can be devised. Acknowledgement for the basic idea is due to the Danish magazine ***Populaer Radio,*** in the April 1979 issue of which appeared a design incorporating filament bulbs and a somewhat different wiring system ("Enkel Quiz-Markor" by G. Moller-Hansen).

## THE CIRCUIT

The circuit of the quiz selector appears in Fig. 1. In this diagram the transistors, resistors, light-emitting diodes and the 9 volt supply are all assembled at a central point, with twin leads, indicated in broken line, passing to the two push-buttons, S1 and S2. When the two push-buttons are open, i.e. not pressed, no current flows in the circuit and both l.e.d.'s are extinguished. If S1 is closed, LED1 lights up and S2 has no effect on the circuit. Similarly, if S2 is pressed, LED2 is illuminated and S1 can exert no control. Thus, the l.e.d.'s indicate which of the two buttons has been pressed first. The circuit is capable of differentiating between the buttons even when the closure of the first occurs only fractionally before the closure of the second.

Fig. 2 illustrates how the circuit functions. Let us assume that push-button S1 has just been closed. Its contacts connect the emitter of TR1 to the negative supply rail, whereupon a bias current flows via LED2, R4 and R3 into the base of this transistor. An amplified collector current flows through LED1 and R1, causing LED1 to light up. Since TR1 is turned fully on, the voltage between its collector and emitter falls to about 0.2 volt. Subsequently pressing S2 cannot cause TR2 to turn on because, being a silicon transistor, it requires a potential of around 0.6 volt between its base and emitter before it can pass base bias current. Pressing S1, therefore, not only turns on LED1 but it also causes the flow of base bias current to TR2 to be inhibited. Had it been S2 which was pressed first, it would have been LED2 which became illuminated, with 0.2 volt appearing between the collector and emitter of TR2 to prevent the subsequent turning on of TR1.

Because of the amplification provided by each transistor, the base bias current flowing in the opposite l.e.d. is very much smaller than that flowing in the l.e.d. which lights up. When, for instance, S1 is pressed, the bias current flowing in LED2 is only some 0.25mA whilst that in LED1 is of the order of

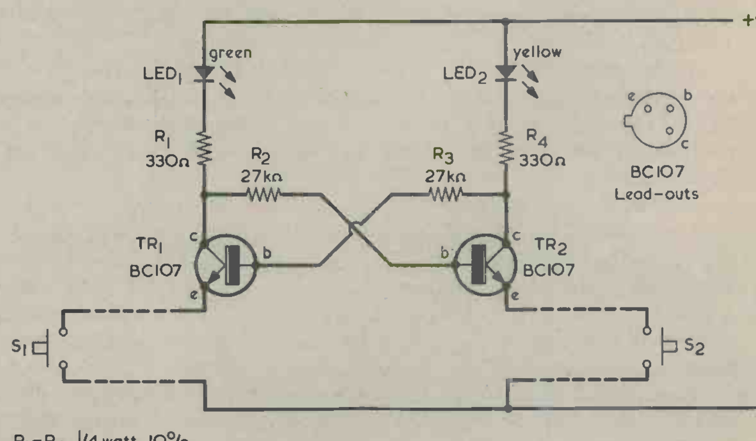



*Fig. 1. The circuit of the quiz selector. The two press-to-make push buttons connect to the main part of the circuit via twin leads*

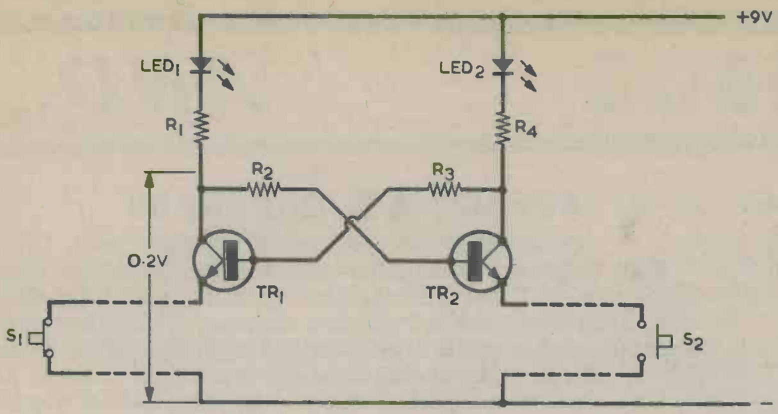



*Fig. 2. Illustrating circuit operation when S1 is the button which is pressed first*

20mA. The l.e.d. colours are a matter of personal choice although it is better to avoid red, as some of the more sensitive red l.e.d.'s emit a glow which is just visible at 0.25mA and this detracts slightly from the effectiveness of the presentation. For the same reason it is also desirable to avoid using the "extra-bright" l.e.d.'s which are offered by some retailers. Standard green and yellow l.e.d.'s emit no noticeable glow at 0.25mA, and have a satisfactory brightness at 20mA.

There is no need for an on-off switch as the circuit consumes no current when the push-buttons are open. The supply current is 20mA when one of the l.e.d.'s is alight, and a suitable battery would be a PP9 or similar. ■

# RECENT PUBLICATIONS

**RADIO REPAIR.** By Les Lawry-Johns. 95 pages, 165 x 110mm. (6½ x 4¼in.). Published by The Butterworth Group. Price £1.50.

This title appears in the Newnes Technical Books "Questions and Answers" series, and has a format in which questions appear in italics, rather like sub-headings, after which the answers are provided. This is a good method of presenting material on a subject such as radio servicing, since it offers breaks in the text which allow for light occasional reading as well as a continual study of the text.

The author is patently a service engineer of considerable experience and the advice given in the book is always helpful and practical. It is refreshing to see references to that arch-enemy of all serviceman: the "Phantom Dabbler" who attempts to "repair" a receiver and in the process introduces far more faults than were originally in existence.

The contents of the book range from transistor radios to unit audio equipment, including a chapter on car radios. There are also separate chapters on noisy operation and valve radios, of which a surprisingly large number are still in daily use. This will be a rewarding book for anyone starting to work in radio servicing.

**YOUR ELECTRONIC CALCULATOR AND YOUR MONEY.** By F. A. Wilson, C.G.I.A., C.Eng., F.I.E.E., F.I.E.R.E., M.B.I.M. 176 pages, 180 x 105mm. (7 x 4¼in.) Published by Bernard Babani (Publishing) Ltd. Price £1.35.

Many of us shy away from calculations when these are not of an obviously simple nature or when they involve such things as multiplications with numbers having more than two or three digits. Nowadays such problems can, of course, be solved in a flash with the aid of a pocket calculator, and yet an inertia still exists which prevents the application of the problem to the calculator.

In the book under review the author deals with the subject of money and shows how inexpensive calculators can be employed to handle money calculations from mortgage repayments to bets on horses. Money is a compelling topic and, when reading the section on electricity charges, this reviewer could not prevent himself from getting out and checking his latest electricity bill! Incidentally, this section of the book also tells the reader how to find the power rating of domestic equipment by observing the number of revolutions of the marked disc in the electricity meter.

The first chapter in the book deals with the arithmetic of money, brushing up what may be a few faded memories on decimals and other mathematical basics. This si followed by a chapter covering domestic expenses, including rates, fuel and decorating, motor car expenses, betting and income tax. Two following chapters then deal with investment and the use of the calculator in a small business. The work concludes with a number of appendices giving tables for conversion factors, compound interest factors, discounted cash flow factors, mortgages, fuel cost comparisons and VAT calculations. Despite the difficulties involved in presenting calculations in print, the text is set clearly and accurately.

# NEWS . . . AND

## LOW-COST LOGIC PROBE

Said to be one half of the cost of any comparable unit, OK's new PRB-1 self-contained digital logic probe greatly simplifies the task of trouble-shooting even the most sophisticated circuits including RTL, DTL, HTL, TTL, MOS, CMOS and microprocessor logic.

Until recently digital electronic servicing had to rely on the oscilloscope for logic level analysis. Although accurate and sensitive, the oscilloscope is also very expensive and not very portable.

However, this new probe is said to rival the best oscilloscopes in performance, yet is completely portable and at £25.93 (Ex. VAT & Packaging) costs a fraction of even the cheapest oscilloscope.

The pen-sized PRB-1 is powered by the circuit under test. Its probe point is steel for durability and is finely sharpened to ensure precise positioning on the circuit or device being examined, as well as to prevent slipping or unwanted shorts.

Another convenience feature of the PRB-1 is that it is permanently adjusted so no recalibration is required. Furthermore, while the PRB-1 is fully compatible with all logic families, no switch resetting or manual adjustments are needed to go from one IC family to another.

The probe body is high impact, and solvent resistant. The light weight power cord is coiled for convenience, detachable, and extends to 6ft (1.8m) if necessary, terminating in mini-alligator clips. The constant brightness LED's are situated for maximum visibility, and a logic truth table is printed above them.

The PRB-1 is manufactured by OK Machine & Tool Ltd., 48a The Avenue, Southampton, Hants. SO1 2SY.

## BBC LOCAL RADIO STATIONS

| | med. wave | vhf |
|---|---|---|
| BIRMINGHAM | 206 | 95.6 |
| BLACKBURN | 351 | 96.4 |
| BRIGHTON | 202 | 95.3 |
| BRISTOL | 194 | 95.5 |
| CARLISLE | 397 | 95.6 |
| | 206 | — |
| CLEVELAND | 194 | 96.6 |
| DERBY | 269 | 96.5 |
| | — | 94.2 |

| | med. wave | vhf |
|---|---|---|
| HUMBERSIDE | 202 | 96.9 |
| LEEDS | 388 | 92.4 |
| LEICESTER | 189 | 95.1 |
| LONDON | 206 | 94.9 |
| MANCHESTER | 206 | 95.1 |
| MEDWAY | 290 | 96.7 |
| MERSEYSIDE | 202 | 95.8 |
| NEWCASTLE | 206 | 95.4 |
| NOTTINGHAM | 197 | 95.4 |

| | med. wave | vhf |
|---|---|---|
| OXFORD | 202 | 95.2 |
| SHEFFIELD | 290 | 97.4 |
| | — | 88.6 |
| SOLENT | 300 | 96.1 |
| (in Bournemouth) | 221 | — |
| STOKE-ON-TRENT | 200 | 96.1 |

## THE STORY OF PYE WIRELESS

The story of Pye Wireless starts in the era when John Scott-Taggart, whose achievements we mention on the next page, was having such an influence on the technically minded public.

A twenty page booklet to mark the 50th anniversary of the formation of Pye Radio Limited is now available to members of the public on application to Pye Limited, Publications Department, 137 Ditton Walk, Cambridge.

The Story of Pye Wireless traces the history of Pye Receivers from when they were originally produced by W. G. Pye & Co. It was from the wireless side of this Company that Pye radio Limited was formed on February 12th, 1929. Written by Gordon Bussey the publication is highly illustrated with photographs of Pye receivers from 1922 onwards and scenes in the Pye factory in Cambridge during those early years.

"My main source of research was Harold J. Pye," said Gordon, "after discovering his whereabouts I spent many hours talking to him about the early days of Pye and I found him to be a truly fascinating man." After graduating from St. John's College, Cambridge with a BA degree (MA 1930) Harold J. Pye joined his father in the business in 1923 and is the last surviving partner of the original W. G. Pye and Company.

The first public demonstration of wireless equipment made by W. G. Pye & Co., was at the Royal Show held in Cambridge in 1922.

# . . . COMMENT

## THE PASSING OF A PIONEER

Our older readers will have learned of the recent death of Wing-Cmdr John Scott-Taggart, at the age of 82, with almost a sense of personal loss.

He was a radio pioneer who, through his books and magazine articles in the early 1920's, caught the interest of thousands of technically minded people. It was said, at the time, that more than 100,000 amateur radio constructors built radios using his ST100 design. He had however had articles published much earlier, his first published article appearing in 1914.

During the First World War, after serving with the Seaforth Highlanders, he became an instructor in wireless to the army, and in the Second World War, after first commanding a radar station in France, he eventually became responsible at the Air Ministry for all radar training.

Older readers will recall the two magazines he founded — 'Modern Wireless' and 'Wireless Weekly' — which were so very popular between the wars. We like to think that, in our modest way, we have worthily continued in the same tradition.

## THE NASCOM STORY

A shining light in the U.K. microcomputer field is Nascom Microcomputers Limited. The history of this company since its inception not only provides a fascinating story in its own right but also aptly demonstrates the meteoric rise of microcomputer development and manufacture over the last year or so.

Nascom Microcomputers Limited was formed in July 1978 following the success of the Mascom-1 microcomputer launched in November 1977 by Nasco Sales Limited. Between then and July 1978 the Nascom-1 was marketed to industrial customers through Nasco Sales and to domestic customers through Lynx Electronic Limited. Both companies are subsidiaries of Nasco Limited, a semiconductor distributor established in 1970.

The Nascom-1 microcomputer was the brainchild of the founders of Nascom Microcomputers, John Marshall and Kerr Borland, who are Managing Director and Marketing Director respectively. With the concept of a microcomputer that would sell for under £200 and be fully expandable, they engaged London hardware specialists, Shelton Instruments, to design a single board computer around Mostek's Z80 CPU.

The microcomputer was unveiled at a seminar in the Wembley Conference Centre at which 100 to 200 delegates were expected. Such was the interest in a microcomputer which was within the reach of personal finances that nearly 600 delegates attended. By the end of the seminar, 350 orders had been received for the Nascom-1.

Having planned to deliver what was thought to be the optimistic figure of 150 computers in the first three months, Nasco were faced with the immediate problem of gearing up to satisfy these orders. In the following 12 months the order book swelled to over 10,000 units and reflected a broad cross-section of British industry from Ministries and the G.P.O. through to major industrial companies, universities, colleges, small electronic research laboratories and personal users.

Early in 1978, Nascom set up a network of distributors in the U.K. The network was expanded into Europe, starting with Germany. As with the U.K., the Nascom-1 was an overwhelming success. The distributor network was then increased to take in all of Europe and Scandinavia. Today, 80 per cent of total sales are to these overseas markets.

At the end of 1978, Nascom placed an order for microprocessors with Mostek U.K. valued in excess of 1.5 million dollars. This is the largest order of its kind ever placed by a British company.

Now announced by Nascom Microcomputers is the Nascom-2, this representing a second major step forward in the history of this company's progress. A success story, indeed.

## REMOTE CONTROL SWITCH

Suitable for Industrial, Commercial and Domestic use, the Kontite supersonic switch can remotely control any individual piece of electrical equipment up to 2 KW power rating.

The switch consists of two parts — an unobtrusive receiver and a light cordless hand-held transmitter complete with battery.

The input-output cables of the receiver are connected to the appliance to be controlled, using a standard three-pin socket and plug and the transmitter aimed at the receiver. The appliance can now be switched on and off from a distance of up to 30/35 ft.

The Kontite remote control switch can be used in the home, office or factory, anywhere where remote operation is desirable.

For further details contact — Kay & Co. (Engineers) Ltd., Acresfield House, Exchange Street, Bolton BL1 1RS.

# Double-and-Halving

## By D. Snaith

### Multiplication by shift of digits

One way in which a computer can multiply two numbers together is by means of repeated addition. With this process the multiplicand (the number to be multiplied) is fed to an accumulator register initially set to zero and is then repeatedly added to the number in the accumulator until the total number of entries is equal to the multiplier. The final sum in the accumulator is then the multiplicand multiplied by the multiplier.

This is a perfectly rational method of carrying out a multiplication, but it has the disadvantage of requiring a lot of additions which, apart from anything else, take up valuable computer time.

**QUICKER METHOD**

A quicker approach is to use the doubling-and-halving method. This is quite simple to follow, but it is first of all necessary to see what happens when we double or halve a binary number.

If we multiply a decimal numbers by 10 we move all the digits one place to the left and insert a zero in the space left at the right. 657 multiplied by 10 becomes 6570. Multiply by 10 again and we get 65700. Should we divide 65700 by 10 we move the digits one place to the right, giving 6570. A further division by 10 produces the first number, 657.

Decimal numbers are based on the radix 10, whilst binary numbers are based on the radix 2. Therefore, if we multiply, say, the binary number 101 by 2 we shift the digits one place to the left and insert a zero, to give 1010. Another multiplication by 2 produces 10100. Dividing 10100 by 2 gives 1010, and a further division by 2 results in the original 101. So, doubling a binary number shifts all the digits one place to the left; halving it shifts all the digits one place to the right.

We can now examine the process of multiplication by doubling-and-halving. As a simple example we shall multiply binary 110 (=6) by binary 10101 (=21) and the steps are shown in Fig. 1. The multiplicand is placed in one register and the multiplier in another register. There is also an accumulator register which is initially set to zero.

| *Multiplicand* | *Multiplier* | *Action* | *Number In Accumulator* |
|---|---|---|---|
| 110 | 10 101 | Add 110 | 110 |
| 1 100 | 1 010 | No action | 110 |
| 11 000 | 101 | Add 11 000 | 11 110 |
| 110 000 | 10 | No action | 11 110 |
| 1 100 000 | 1 | Add 1 100 000 | 1 111 110 |
| 11 000 000 | 0 | | 1 111 110 |

*Fig. 1.*

The number in the multiplier register is examined and if the least significant digit (that at the extreme right) is 1, the number in the multiplicand register is added to the accumulator. This occurs in the first step of Fig. 1. The multiplicand is then doubled and the multiplier halved, bringing us to the second step. The right hand 1 in the multiplier which was present in the first step is now dropped out of the multiplier register since it has served its purpose, and the least significant digit in the muliplier register is a 0. No action is taken.

```
    110
  10101
  -----
    110
  110
110

1111110
```

*Fig. 2.*

On the third step the multiplicand is again doubled and the multiplier halved. The least significant figure in the multiplier register is once more 1, and this results in the number in the multiplicand register being added to the number in the accumulator. The process repeats in the fourth step (no action) and in the fifth step (addition to accumulator), whilst in the sixth step there is no number left in the multiplier register. The result of the multiplication (equal to decimal 126) is then the number which is present in the accumulator.

The doubling-and-having process of multiplication obviously takes much less time and requires far fewer operations than does repeated addition. Also, shifting digits in a register to the left or to the right is a basic computer operation.

There is no necromancy in Fig. 1, since all we are effectively doing is getting the computer to do the multiplication sum which is shown in Fig. 2. Things get more involved and roundabout when the sum is handled by the computer, but then who ever said that computers are easy? ■

DATABUS **really explains microprocessors**

**series No. 3**

By Ian Sinclair

# SELECTION AND BUSSING

**This is the third in our 12-part series which takes the lid off microprocessors**

In part 2 we looked at memory chips, ROM and RAM. Each memory chip stores a large number of bits, however, so how do we go about selecting one? Take a simple example of two bits only in a ROM (Fig. 1). We could select which one we wanted by using a signal into a gate, 0 for one stored bit and 1 for the other. But suppose we have eight stored bits in a ROM. We now need to be able to select one bit out of eight, and th is can be done by gating, this time combined with binary counting, in a circuit called a multiplexer. This particular example will use an 8 to 1 multiplexer, which could be a separate circuit, but is much more useful if it's built into the memory i.c., since this will cut down the number of connections that have to be made outside the i.c. multiplexer. What does it do? There are 8 inputs to the multiplexer, each connected to a stored bit. There's one output and there are three control lines. The way it works is delightfully straightforward. The three control lines can *each* be set to 1 or 0, so that we could use control symbols 001 010, 011, 100 and so on. Now 001 is 1 in binary, and this set of control signals connects bit No. 1 to the output. With 010 (2 in binary) selected, bit No. 2 is connected to the output. With 011 (3) selected, bit No. 3 is connected to the output and so on. Control 000 can be used for bit 8, in this scheme.

## ADDRESS LINES

This is a comparatively simple example. The control signal inputs are called address lines, because the digital number which is formed by the bits on these lines is an "address", a code number which will fetch one bit from memory. Each bit that is stored in the memory has its own address, the combination of signals on the address inputs which makes the gates connect to that particular part of memory.

By using three address lines, we can make connections to eight separate bits in this memory. This way we have avoided using five pin connectors, at the minor expense of more complicated circuits inside the i.c. The savings become a lot more significant when we use larger memories. Four address lines will access (make connection to) sixteen bits of memory, saving 12 pins. Five address lines can access 32 bits of memory — 27 pins saved. Use ten address lines, and the number of stored bits that can be accessed is 1024 — we wouldn't think of using that many pins!

That's all very well, of course, but where do these address line signals come from? The answer is that they are generated inside the microprocessor CPU

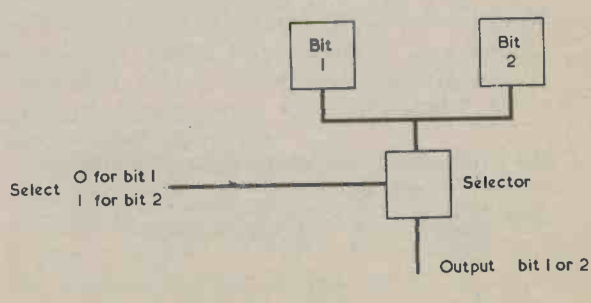
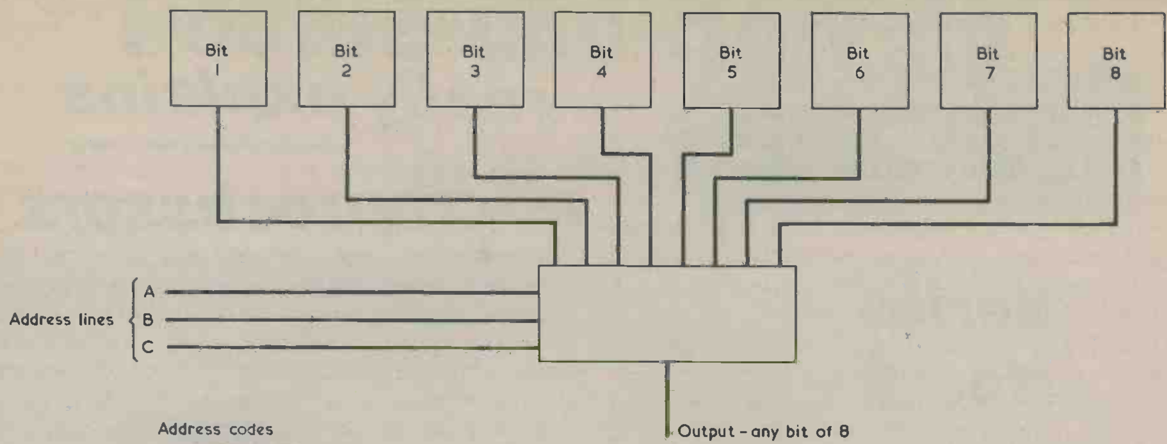



*Fig. 1. Selecting one bit from two, using a selector gate switch*




Address codes

| A | B | C | Bit No. |
|---|---|---|---|
| 0 | 0 | 1 | 1 |
| 0 | 1 | 0 | 2 |
| 0 | 1 | 1 | 3 |
| 1 | 0 | 0 | 4 |
| 1 | 0 | 1 | 5 |
| 1 | 1 | 0 | 6 |
| 1 | 1 | 1 | 7 |
| 0 | 0 | 0 | 8 |

*Fig. 2. Selecting one bit out of eight. The three select (or address) inputs can carry binary numbers up to eight, so that gates can select each possible number, and gate a different bit for each address number*

itself, some by a simple counting action, and others rather differently as we shall see. Most CPU's, apart from the simpler variety, have sixteen address lines, so that they could address 65536 bits of memory. This is a lot more than is needed for most applications, but it's nice to have in reserve!

A memory i.c., then, will have address pins, so that the signals from the CPU will select the correct part of memory, and one (or more) data pins at which signals will be taken from or passed to the memory. Incidentally, we refer all these operations to the CPU — we use "read" to mean a memory passing data to the CPU and "write" to mean the CPU passing data to the memory. One chip has an output and the other has an input, but the important one is the CPU.

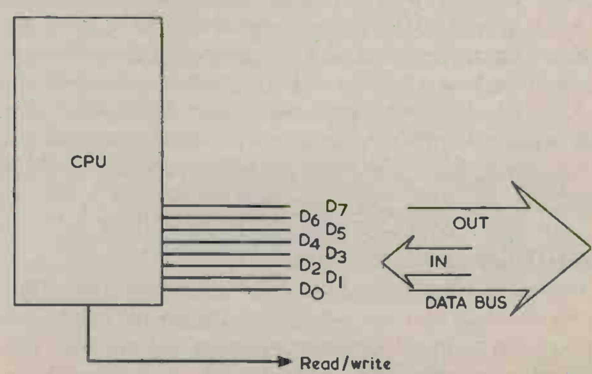
If the memory is a read/write type (RAM) an additional signal is needed. At its simplest, the memory i.c. might use a READ/WRITE pin, with a control signal which might be 0 for read, 1 for write. Where does *that* signal come from? Right again, from the CPU, and the signal has to be generated under the control of the program.

Now you can see why a microprocessor must have a program which is set in a ROM. Without a program, there can be no read or write signals, the address signals would follow a simple sequence (see later, Part 4), and no data signals could be sent out. A very reasonable question to ask at this point is how we can ever start a program running, if we need a program to run the CPU! That's one we'll deal with later; for the moment let's look at some hardware — the connections between the CPU and the memory i.c.'s.

## DATA PINS

Microprocessors operate with eight bits, a byte, at a time. To feed in 8 bits need eight pins, called the data pins, at the CPU, and these are both inputs and outputs, unlike the address pins which are for outputs only. When are the data pins used for outputs and when are they used for inputs? They are used as outputs when the CPU is storing bytes into memory, and when this happens there will be a signal from a READ/WRITE pin which switches all

*Fig. 3. The data pins of the CPU. There are eight data pins, labelled D0 to D7, and the direction of data (in or out) is controlled by the signal (0 or 1) on a read/write pin*



the RAM memory so that data bits can be stored. When the microprocessor needs to take in data from the memory, the read signal is selected by the voltages on the address pins. If, by some mischance, a ROM is selected for write signals, nothing happens, but we should design the system so that the CPU never attempts to write into a ROM.

The next part to note is the way memories are organised inside. Some memory i.c.'s are made so that each address number connects just one single bit to an output/input pin; others connect 2 bits, 4 bits or 8 bits to as many data pins.

The different ways of arranging memories are indicated in the way a memory is described. For example, a 1024 x 1 memory is one which can store 1024 ($2^{10}$) single bits of memory. Such a memory would have ten address pins, so that a number up to 1024 (in binary) could be selected resulting in a bit, 0 or 1, appearing on the output pin. A 512 x 4 memory, on the other hand, can store 512 sets of four bits. It would use nine address pins (because 512 is $2^9$), and would have four data output pins, with a different bit appearing on each pin. A 128 x 8 memory would be able to store 128 complete 8-bit bytes, with seven address pins (because 128 is $2^7$) and eight data pins.

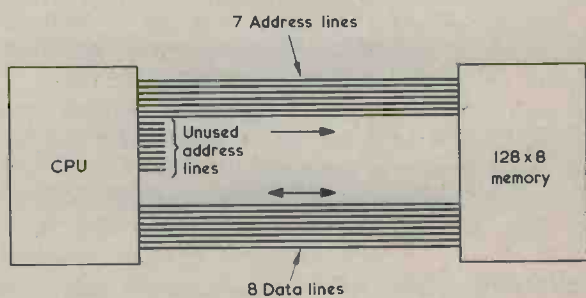
which selects the data of byte number 1 and so on. Nothing is lost, the microprocessor simply runs through all the 128 stored bytes again.

## ENTER BUSES

What happens, though, if we need more memory and we use four of these 128 x 8 memories? This is where buses come into the picture. A bus is a set of lines, with each line connecting a pin on the CPU to the corresponding pin on other chips. A data bus will need eight lines, and in our example of a CPU connected to four 128 x 8 memories, each line will connect to five pins, one of the CPU and one from each memory. When you think about it, this is the only way it could be done unless we were prepared to have i.c.'s with hundreds of pins. The address pins also are connected to a bus, this time with sixteen lines. Along each one of these lines, a CPU address pin and an address pin of each memory will be connected.

The problem now is, how do we make sure that the signals go the way we want? After all, if we have four 128 x 8 memories, and we ring up number 6 byte by placing 0000110 on the address lines, won't each memory connect up its number 6 byte to

*Fig. 4. Using address and data bus lines between the CPU and a memory. The address lines carry signals from the CPU to the memory, the data lines can operate in either direction. The group of lines is called a BUS because it can link several destinations*




Now it's easy to see how we could connect a 128 x 8 ROM to the CPU — we would start by connecting the eight data pins of the ROM to the eight data pins of the CPU. The pins are labelled in the same way, so there's not much of a problem about that. How do we connect the address pins, though? A 128 x 8 memory uses only seven address pins, and the CPU has 16, so how do we ensure that the correct connections are made? The answer is simple if only one 128 x 8 memory is connected to the CPU. The seven address lines of the memory are labelled A0, A1 . . . A6 (not to A7, because the first line is, confusingly, A0 rather than A1), and these are connected to the identically labelled pins of the CPU. What about the others? Ignore them! This is possible because with only one ROM, the CPU can count out addresses starting at 0000000 and ending, as far as a 128 x 8 memory is concerned, with 1111111. The next number is 10000000, but the 1 is now on a line which is not connected, and the remaining numbers simply select address 0000000 in the memory. The next count is 100000001,

the data lines?

If this were all there were to it, it would, and the result would be chaos, but there's a way out. It takes the form of a "chip select" signal, which can be as simple as a single pin on the memory i.c., taken to logic 1 if the chip is to be used, and left at logic 0 if the chip is not wanted. With the chip-select pin set to 0, the data output pins are at neither 1 or 0, they are "floating", disconnected, free to take up whatever voltage is on the line to which each one is connected. This sort of system is sometimes called three-state or tri-state logic; as well as 1 and 0 there is an isolated state. This method of switching is extremely useful, as we shall see in other examples.

Returning to the problem of the four 128 x 8 memories, the use of a chip-select pin on each memory allows us to make use of all four memories to give a total of 4 x 128 = 512 bytes of memory. The method involves gating, using the outputs of the previously unused address lines. We are using seven address lines, A0 to A6 for the memories, so

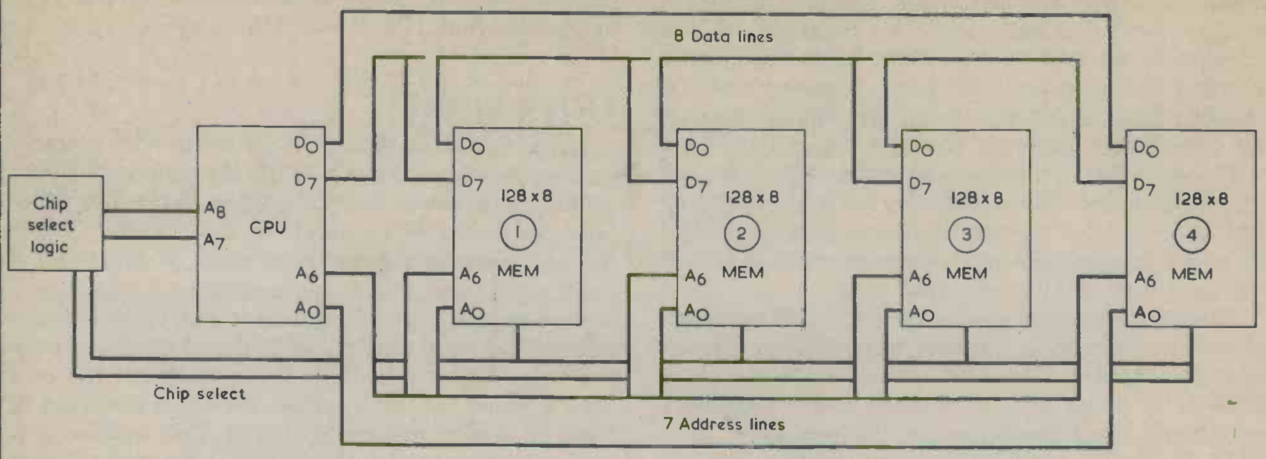



*Fig. 5. Connecting four memory chips into a bus. Two address lines are used to provide chip-select signals to ensure that the correct memory i.c.'s are addressed by the other address lines*

that A7 to A15 are left. All we have to do is to use lines A7 and A8 in a gating system, so that when the voltage on each is 0 (A7 = 0, A8 = 0) then memory i.c. 1 is selected, when A7 = 1, A8 = 0, memory i.c. 2 is selected; when A7 = 0, A8 = 1 memory i.c. 3 is selected, and when A7 = 1, A8 = 1, memory i.c. 4 is selected. Once again, if we use no other memories, the lines A9 to A15 can be left open circuit, and the count will simply start again at zero when a 1 appears on A9.

## MACHINE CONTROL

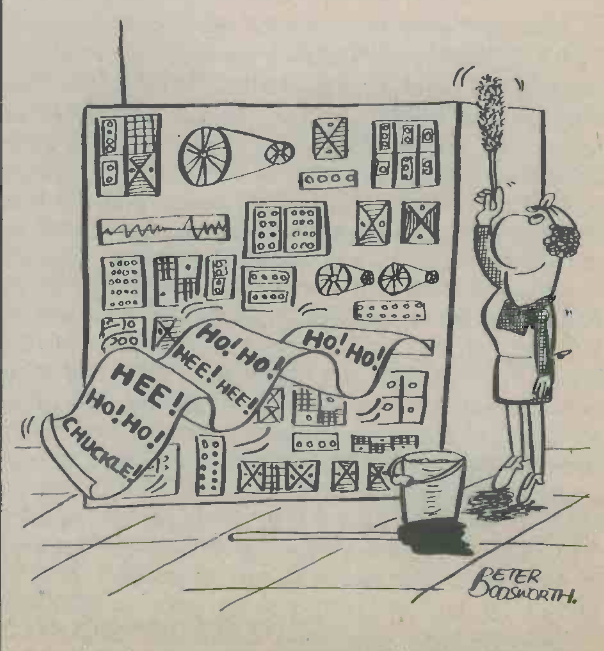
Quite a lot of simple machine control systems could be designed with only 128 bytes of memory, and a few CPU's are designed to make the most of simple systems. The National Semiconductor 8060 (better known as SC/MP), for example, uses only up to twelve address lines; though another four address bits can be obtained on other lines if needed; and the Fairchild F8 also uses a restricted set of address lines — none at all, in fact!

How do we go about using a 1024 x 1 memory? Such a memory needs ten address lines, connected through a bus to the CPU. To make up a complete byte, we have to use eight of these memory i.c.'s in a set, with each one connected to its own data line. Once again, if we need more memory we will have to make use of the chip-select pins to decide which lot of i.c.'s we want to use.

For RAM memory, of course, there is an additional line of bus connecting the READ/WRITE pin of the CPU to the corresponding pin on each RAM. The READ/WRITE control is the key to the problem of getting a program started, incidentally. This control is arranged so that when the CPU starts up (after power on or reset), the READ/WRITE control is set to read, reading memory to provide some program data.

That brings up to RESET. The reset input of the CPU, in the horrible jargon of microprocessors, initialises everything. In plain English, that means everything starts from scratch — and scratch means that all shift registers are set so that each output is zero. The address lines are also set to zero output, the read/write controls are set so that the READ signal is sent out, and everything is ready for operations — next month!

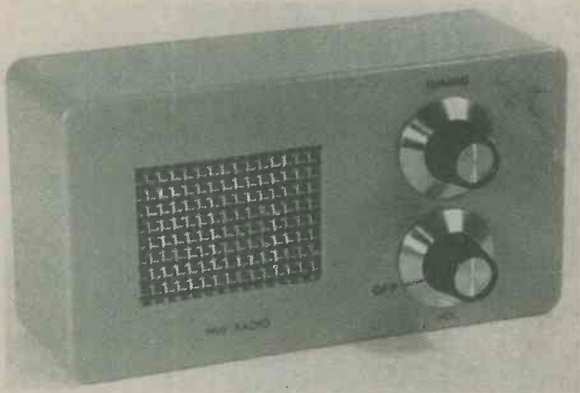
*(To be continued)*



# RADIO & ELECTRONICS CONSTRUCTOR

## *IN OUR NEXT ISSUE*

## SINGLE-CHIP M.W. RADIO



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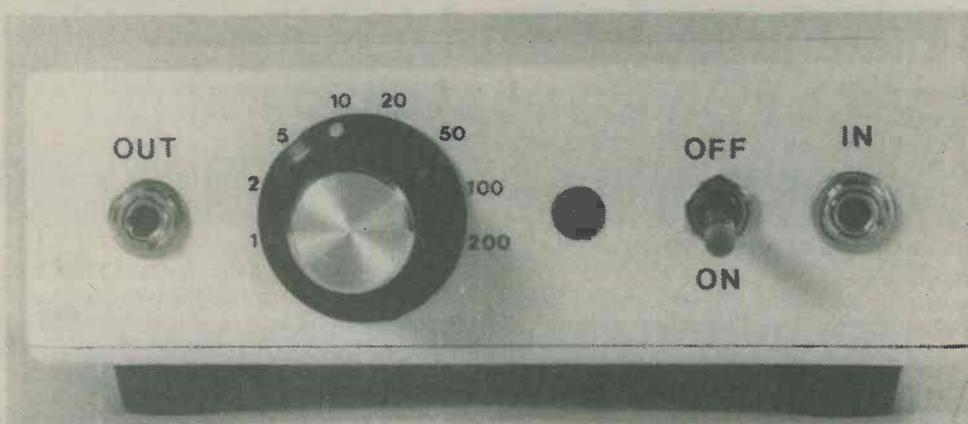


*CMOS Wire Guard Alarm System*
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# SHORT WAVE NEWS
## FOR DX LISTENERS

**By Frank A. Baldwin**

*Times* = GMT *Frequencies* = kHz

What has been happening since last I wrote? Well, apart from some beer brewing and wine making, gardening and watching the local wild life, non-human I hasten to add, some short wave listening was possible at times — but only just!

From correspondence and self observations the country most in the news of late is —

**● SOUTH KOREA**

My old friend Bob Iball of Worksop has been monitoring Seoul on **6480** for some time and from his observations it seems that Radio Korea operates on this channel from 1600 to 1630 in English to the Middle East and North America; from 1630 to 1700 in French to the Middle East and from 1900 to 1930 in Arabic to the Middle East.

A new correspondent, A. Dupres of Cardiff, reports logging Radio Korea at 2000 on **7550** in English to Africa and Europe and also on **15570** with the Spanish programme to Europe from 2130 to 2200. Just 15 years of age, A.D. is set fair to becoming an experienced SWL and maybe, in time, a good Dxer.

For those of my readers who are interested in logging some of the English transmissions from Radio Korea (afternoon and evening sessions) here is the schedule at the time of writing.

From 1400 to 1430 on **9870**, **11665** and on **12090** to Europe and S.E. Asia; from 1600 to 1630 on **6480**, **9720**, **9870** and on **11830** to the Middle East and N. America; from 1800 to 1830 on **11830** and on **15255** to N. America; from 2000-2030 on **7550**, **9870**, **11525** and on **15570** and from 2300 to 2330 on **7275** and on **7550** to Europe and N. America.

KBS (Korean Broadcasting System) Seoul identifies as "Radio Korea, the Overseas Service of KBS".

**● NETHERLANDS ANTILLES**

Radio Nederlands Relay, Bonaire, on **9715** at 0550, Dutch pops in a programme for North America (West Coast), scheduled from 0530 to 0625 and also in parallel on **6165**.

**● SWITZERLAND**

Berne on **9725** at 0606, OM with the French programme to North American (West Coast) scheduled here from 0600 to 0630 and in parallel on **6045**.

**● EAST GERMANY**

Berlin International on **9730** at 0608, OM with the German programme for East, West and North West Africa, the Near East and South Arabia, scheduled from 0530 to 0615.

**● WEST GERMANY**

Berlin on **7285** at 0612, OM with the German programme to South Asia and Australasia, scheduled from 0600 to 0950.

**● VATICAN CITY**

Vatican on **7250** at 0618, Latin Mass to Europe, scheduled from 0630 to 0700 (to 0715 on Sundays).

**● ITALY**

Caltanisetta on **7175** at 0622, YL with a talk in a relay of the Domestic Service 2nd Programme to the Mediterranean Basin, scheduled Sundays only on this channel from 0500 to 1300 and from 1330 to 2230. The power is 5kW.

**● GREECE**

Athens on **7125** at 1923, OM with a local newscast in the English programme for Europe, scheduled from 1920 to 1930 (newscast only).

**● CUBA**

Havana (via Moscow Relay) on **17710** at 1740, OM and YL alternate with an account of the history of Cuba in the English programme for the Mediterranean Area, scheduled from 1700 to 1800.

**● MOROCCO**

Rabat on **15155** at 2020, drama in the Arabic Domestic Service, scheduled here from 1900 through to 0100 and in parallel on **21735**.

**● IRAQ**

Radio Baghdad on **7170** at 2025, OM with a newscast in Arabic in the programme "Voice of Egypt Arabism", scheduled from 2000 to 2200.

**● LIBYA**

Tripoli on **15100** at 2031, OM with anti-Sadat tirade in Arabic in the programme "Voice of the Arab Homeland" in the External Service, scheduled here from 1700 to 2200. The Domestic Service is relayed here from 0800 to 1700.

**● SAUDI ARABIA**

Riyadh on **15060** at 1943, OM with a talk about English poets Byron and Shelley in the Arabic Domestic Service, scheduled here from 1500 to 2300.

**● KUWAIT**

Radio Kuwait on **9840** at 1805, YL with songs then local mx in the Arabic Domestic Service, scheduled from 1600 to 1910 on this channel.

**● ISRAEL**

Jerusalem on **17630** at 1840, YL with a talk in the Domestic Service Network B programme, scheduled here from 0610 to 2310, in Hebrew.

Jerusalem on **17645** at 2002, OM with the English programme for Europe, North America and Africa, news of the peace treaty arrangements. Also in parallel on **17685** but former channel is best for U.K. listeners.

**● SOUTH AFRICA**

Meyerton on **4835** at 2100, OM with a newscast in English after station identification. The schedule is from 0358 to 0635 (Saturday from 0430, Sunday from 0500), 1520 to 2115 (Saturday until 2205).

**● MOZAMBIQUE**

Radio Mozambique, Maputo, on **3210** at 2047, YL with folk songs in Portuguese. The schedule is from 0255 to 0530 and from 1630 to 2210 with an English programme from 1800 to 1815. The power is 100kW.

**● LIBERIA**

ELWA Liberia on a measured **3227** at 2050, OM with a talk in vernacular in the Home Service, scheduled here from 0610 to 0800 and from 1805 to 2220, the power being 10kW.

**● MALAGASY**

Tananarive on a measured **3287.5** at 2054, piano jazz music in European style. This is the Home Service in French and Malgache, scheduled from 0300 to 0600 and from 1300 to 2100, the power being 100kW.

**● GHANA**

Accra on a measured **3366** at 2100, African drums, OM with identification and the local news in English. The schedule is from 0530 to 0805 (Saturday and Sunday until 0900), from 1600 to 2305 and the power is 10kW.

**● ANGOLA**

Radio Nacional, Luanda, on **3375** at 2101, OM in vernacular (presumably the news). The schedule is from 0400 (Sunday from 0430) to 0800 and from 1530 to 2400. This is a Programme in Portuguese except for the period 2100 to 2130 when in Kikongo. The power is 10kW.

**● VENEZUELA**

Radio Libertador, Caracas, on **3245** at 0223, YL with pop song, OM with announcements in Spanish. The schedule is from 1000 to 0400 and the power is 1kW.

Radio Bolivar, Ciudad Bolivar on 4770 at 0253, Latin American music, OM announcements in Spanish. The schedule is from 1000 to 0300 and the power is 1kW.

Radio La Puerto la Cruz, Puerto la Cruz, on **3365** at 0232, local pops, OM with announcements in Spanish. The schedule is from 1000 to 0400 and the power is 1kW.

**● ECUADOR**

Radio Iris, Esmeraldas, on **3380** at 0237, pop records local style, OM with announcements in Spanish, several mentions of Esmeraldas (local addresses). The schedule is from 1100 to 0300 (closing time is variable) and the power is 10kW.

Radio Zaracay, Santo Domingo, on **3390** at 0239, local pops on records with OM announcer in Spanish. The schedule of this one is from 1000 to 0500 but the closing time is variable. The power is 10kW.

La Voz de Galapagos, Isla San Cristobal, on **4810** at 0302, OM with love song after OM announcer with identification. The schedule is from 1215 to 1430 and from 2300 to 0400 (but sometimes closes at 0430). The power is 5kW.

La Voz de Los Caras, Bahia de Caraquez, on **4795** at 0417, YL with a song in typical Ecuadorian style — pop version — after OM with identification. The schedule is from 1300 to 0400 (Sunday until 0520 — which is the day I logged it, catching up on lost sleep the same afternoon!) The power is 3kW.

**● BRASIL**

Radio Rural de Santarem, Santarem, on **4765** at 0250, YL with a religious talk in Portuguese. This one has a schedule from 0800 to 0400 and the power is 10kW.

Radio Brasil Central, Goiania, on **4985** at 0240, OM with guitar and a ballad about unrequited love. This station has a 24-hour schedule and the power is 5kW.

**● BOLIVIA**

Radio Nueva America, La Paz, on a measured **4797** at 0255, YL with love song in Spanish, orchestral music, identification. The schedule is from 1030 to 1830 and from 2100 to 0400 (Sunday to 0200) and the power is 1kW.

**● COLOMBIA**

Emisora Meridiano 70, Arauca, on **4925** at 0318, OM with announcements in Spanish, dance music 1930's style, identification 0324 "Somos Emisora Meridiano 70 de Arauca". The schedule is from 1000 to 0330 (Saturday until 0500) and the power is 1kW. The frequency of this one is apt to vary from that above to **4930** and it sometimes identifies as Radio Centro!

**● NOW HEAR THIS**

Radio Ondas del Huallaga, Huanaco, Peru, on **3330** at 0410, OM with announcements in Spanish, short musical excerpts — more talk than music — mostly noticias. The schedule is from 1015 to 0600 but closing can vary from 0400 to 0900. The power is just 0.5kW.

# 10 Watt VMOS Amplifier

## By R. A. Penfold

**It is now possible to design amplifiers having output stages incorporating VMOS power field-effect transistors in the output stage, and it is a simple VMOS Class B amplifier which is described**

## Power f.e.t. Class B output with negative temperature coefficient

Virtually all contemporary audio power amplifiers have a Class B bipolar transistor output stage, the main exceptions being a few valve designs and designs which incorporate transistors in modes other than Class B. But it is now possible to design amplifiers having output stages incorporating VMOS power field-effect transistors in the output stage, and it is a simple VMOS Class B amplifier which is described in this article.

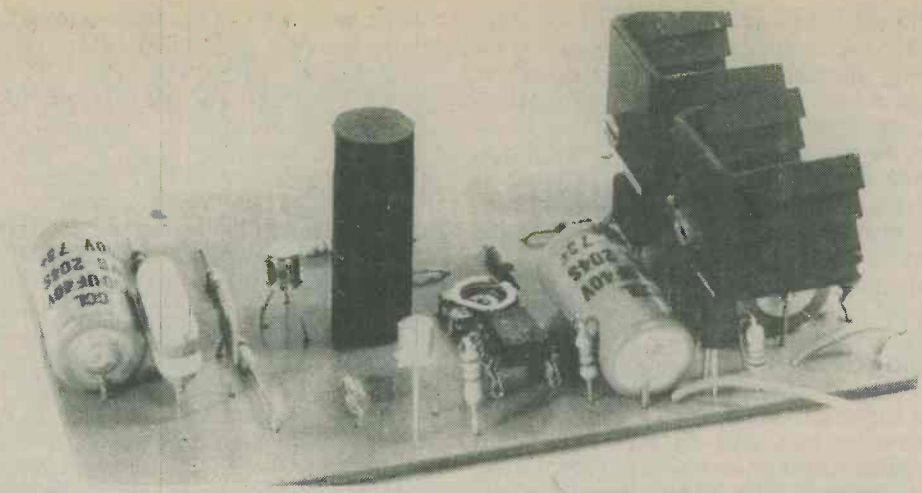
### TEMPERATURE COEFFICIENT

One of the important advantages of a VMOS device in this type of circuit is its negative temperature coefficient, which gives better thermal stability than is possible with positive temperature coefficient bipolar transistors. Problems with thermal stability arise due to the need for a small quiescent current through the output transistors to combat the effects of crossover distortion. Since bipolar transistors have a positive temperature coefficient, this bias current tends to increase when the amplifier has been in use for a while and the output transistors have become heated up. The increased bias current causes more heating of the output transistors and, in turn, a further increase in the bias current. Unless suitable precautions are taken, this regenerative effect could continue to the point where the dissipation in the output stage becomes excessive, leading even to the possibility of the output transistors becoming destroyed. In order to overcome this thermal runaway problem it is usually necessary to employ what is virtually the lowest acceptable initial bias current and to incorporate some form of thermal stabilization circuit.

These difficulties do not exist with power f.e.t.'s because a rise in their temperature merely alters the bias characteristic so that there is a marginal reduction in the current flowing under quiescent bias conditions. It is by no means essential to incorporate any thermal stabilization circuitry in an f.e.t. Class B design, nor is it necessary to use a bias which causes a minimal standing current. It is perfectly in order to have a comparatively high initial standing current which falls to a lower but still more than adequate level after the amplifier has been in use for some time.

Another advantage of power f.e.t.'s over bipolar output devices is the far lower drive current requirements of the former compared with the latter. Whereas a simple bipolar Class B amplifier having an output power of, say, 10 watts r.m.s. would need a driver stage operating at a collector current in the region of 50mA, an f.e.t. design could, if desired, operate from a driver stage having a collector current of only a fraction of a milliamp. Darlington pairs or equivalent configurations are often used in output stages to reduce the drive current requirement, but even these need more input current than do power f.e.t.'s.

There are disadvantages with VMOS devices in Class B audio output stages, one of these being that they are slightly less efficient than bipolar transistors. This is not a major drawback, however, and simply means that the power supply has to provide

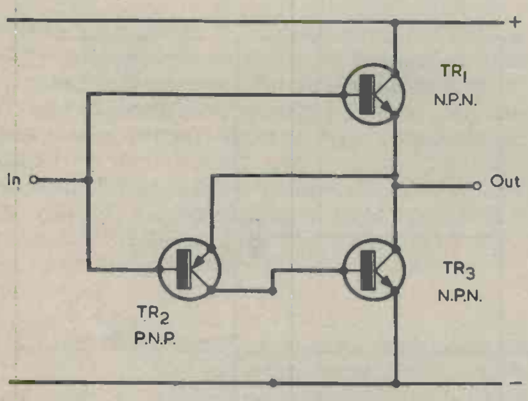


*The amplifier is assembled on a small printed circuit board having dimensions of 4½ by 3in.*

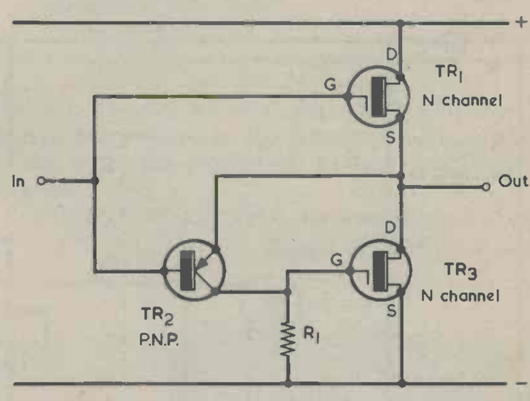
a slightly higher supply voltage to produce the same output power into a given load impedance. A second disadvantage is not due to the power f.e.t. in itself but arises from the present availability of these devices. Only n-channel VMOS devices are generally available at the time of writing, which means that a quasi-complimentary arrangement instead of a true complementary output stage must be used.

## QUASI-COMPLEMENTARY CIRCUIT

A representative quasi-complementary circuit which was popular in the earlier days of transistor amplifiers before proper complementary n.p.n. and p.n.p. devices became available is shown in Fig. 1(a). In this diagram, both the output transistors are n.p.n. devices. TR1 is a simple emitter follower which supplies the high output current required by the load on positive-going output excursions. Being

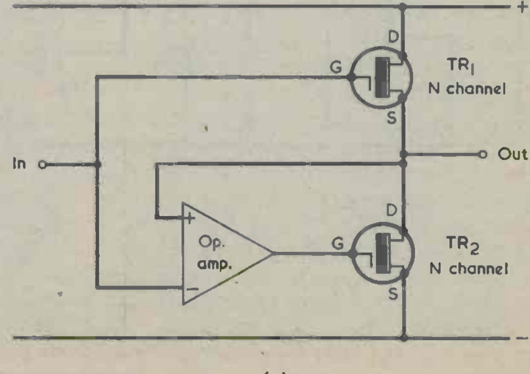



(a)




(b)

*Fig. 1(a) A quasi-complementary a.f. output stage which allows the two output transistors to have the same polarity*
*(b) Employing a similar approach when the two output transistors are n-channel VMOS devices*
*(c) An alternative method of driving the lower transistor, using an operational amplifier*




(c)

an emitter follower it has only about unity voltage gain and its input and output are in phase.

It is necessary for the lower half of the output stage to provide a high output current on negative-going excursions and to have the same basic characteristics as an emitter follower. An n.p.n. emitter follower cannot be employed because it would have the wrong polarity. If the lower transistor had its emitter connected to the negative supply rail and its collector connected to the output load the supply polarity would be correct but the transistor would not operate like an emitter follower. Apart from any considerations of gain, the transistor would function in the common emitter mode and its output at the collector would be out of phase with its input at the base.

The configuration can still be made to work, however, by adding another transistor, TR2, ahead of the output transistor. The added transistor is a small p.n.p. type which is also in the common emitter mode and, since both transistors invert the signal the output is now in phase with the input at TR2 base. Also there is 100% negative feedback between TR2 and TR3, so that the two transistors give the same unity voltage gain as does the single emitter follower used in the upper section.

Fig. 1(b) shows the same approach with an output stage having two n-channel VMOS devices, TR1 and TR3, and the p.n.p. bipolar transistor, TR2. TR1 is now a source follower and TR3 a common source amplifier, and at first sight the circuit should function in the same manner as the previous one. R1 is added to provide a collector load resistance for TR2, and is necessary because the input impedance of TR3 is far too high to provide suitable loading.

In practice the arrangement of Fig. 1(b) does not work very well. This is because on high negative-going current peaks, which are required to be well in excess of 1 amp, the drain of TR3 should fall to about 2 volts positive of the negative rail; whilst the gate voltage needed to produce these current peaks is of the order of 5 to 10 volts positive of the negative rail. Since TR2 collector must always be negative of its emitter the maximum output current from TR3 is limited to a level at which TR3 drain is slightly positive of its gate, and the result is poor efficiency and high dissipation in TR3. This problem does not arise in the circuit of Fig. 1(a) because the bipolar TR3 here can draw a very high collector current when its base is only about 0.7 volt positive of the negative rail.

Attempts made by the author to modify the basic circuit to give an improved performance were not successful, and so the unusual arrangement of Fig. 1(c) was tried instead. Here, the lower output transistor is preceded by an operational amplifier. This circuit provides unity voltage gain due to the 100% negative feedback given by connecting the drain back to the non-inverting input of the op-amp. Note that the signal is inverted in TR2 and so the feedback is applied to the non-inverting input of the op-amp, and not the inverting input as would normally be the case. The input signal is applied to the inverting input, and the duel inversions in the i.c. and in TR2 give the required phase relationship between input and output. The output of the op-amp can swing to virtually the full positive supply rail voltage, which is much more than is required to drive TR2 into saturation.

Athough rather novel, the arrangement of Fig. 1(c) is found to give extremely good results in practice, and is that employed in the final amplifier circuit.

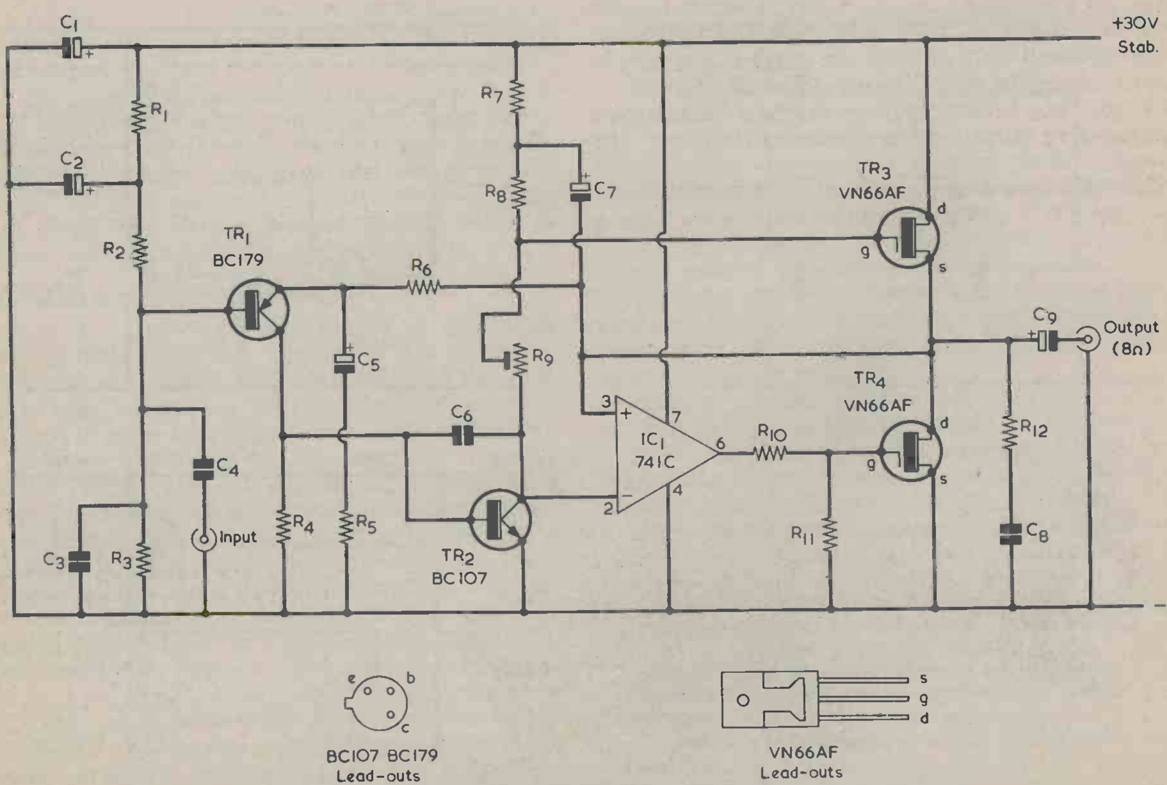



*Fig. 2. The circuit of the VMOS Class B amplifier. A stabilized 30 volt supply enables an r.m.s. output power of 10 watts to be given*

## FULL CIRCUIT

The full circuit of the VMOS amplifier is given in Fig. 2. The output stage is very much as has just been described, the main difference being the inclusion of the potential divider, R10 and R11, between the output of IC1 and the gate of TR4. This potential divider is needed because the negative output swing of the 741 employed is limited to about 2 volts positive of the negative rail which, if applied direct to the gate of an output f.e.t. which happened to have a low gate threshold voltage, could bias the f.e.t. quite hard on. The potential divider ensures that TR4 can be biased to the off state. At the same time, its values are such that TR4 can still be turned hard on when the output of IC1 swings positive.

C9 is the output d.c. blocking capacitor. R12 and C8 form a Zobel network which contributes to the stability of the circuit.

TR1 is a common emitter input transistor which is directly coupled to the common emitter driver transistor, TR2. There is virtually 100% d.c. negative feedback applied to the overall amplifier through R6, with R2 and R3 biasing the input (and consequently the output) to about half the supply voltage. R1 and C2 are smoothing components which prevent hum and noise from the supply being applied to the amplifier input by way of R2 and R3. C4 provides d.c. blocking at the input, and C3 is an r.f. filter capacitor which aids stability. So also does C6, which rolls off the very high frequency response of TR2.

R8 is the main collector load for TR2, whilst preset potentiometer R9 is adjusted to provide the desired quiescent bias for the output stage. C7 and R7 are bootstrapping components and they allow the upper end of R8 to go positive of the positive supply rail during positive output voltage excursions. This bootstrapping is essential because, if the positive voltage at TR3 gate were limited to the positive supply rail voltage, the minimum drain-to-source voltage across TR3 would be as high as 8 to 10 Volts. The bootstrapping allows a comfortably high positive output voltage to be available at TR3 source.

Since C5 has a low reactance at audio frequencies, the a.f. feedback components consists of R6 and R5. The a.c. voltage gain of the amplifier is approximately equal to R6 divided by R5, or about 18 times with the specified values for these components.

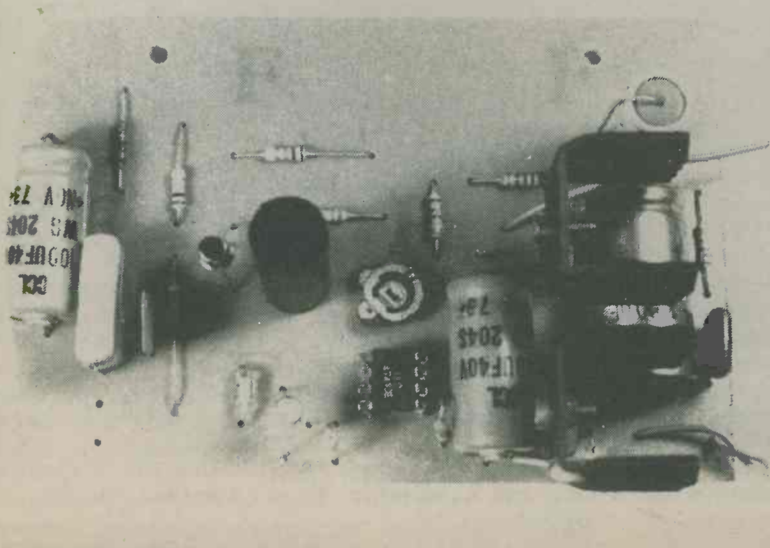
With a 30 volt supply the amplifier will give an

*Resistors*
(All fixed values ¼ watt 5%)
R1 18k Ω
R2 100k Ω
R3 100k Ω
R4 680 Ω
R5 56 Ω
R6 1k Ω
R7 680 Ω
R8 6.8k Ω
R9 2.2k Ω pre-set potentiometer, 0.1 watt horizontal.
R10 4.7k Ω
R11 5.6k Ω
R12 2.2 Ω

*Capacitors*
C1 100μF electrolytic, 40V Wkg.
C2 100μF electrolytic, 40V Wkg.
C3 180pF ceramic plate
C4 0.47μF type C280
C5 150μF electrolytic, 25V Wkg. (see text)
C6 10pF polystyrene or ceramic plate
C7 100μF electrolytic, 25V Wkg.
C8 0.1μF type C280
C9 1,000μF electrolytic, 25V Wkg.

*Semiconductors*
TR1 BC179
TR2 BC107
TR3 VN66AF
TR4 VN66AF
IC1 741 in 8-pin d.i.l.

*Miscellaneous*
Printed circuit board
Heatsink (see text)
Wire, solder, etc.



The components are laid out neatly on the board without cramping

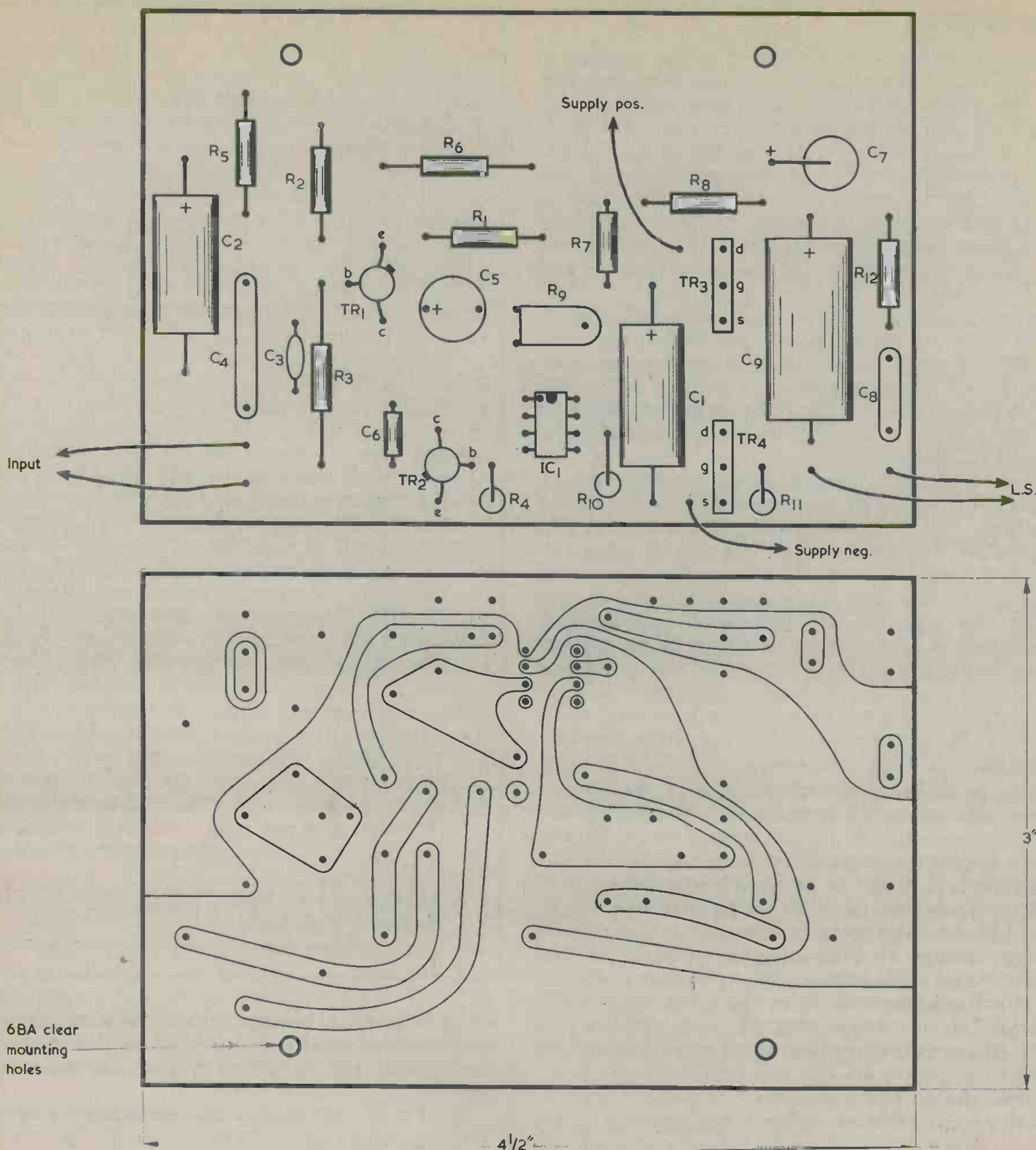



*Fig. 3. Component and copper sides of the printed circuit board. This is reproduced fullsize*

output of approximately 10 watts r.m.s. into an 8Ω loudspeaker, and about 500mV r.m.s. is needed at the input to fully drive the circuit. The gain can be proportionally increased or decreased by reducing or raising (respectively) the value of R5, but this value should not be greatly altered from the specified figure. Large alterations could result in either instability or a loss of output quality.

The signal-to-noise ratio of the prototype is slightly better than –80dB (unweighted, with input open-circuit). The distortion performance is roughly comparable to simple Class B bipolar designs with a t.h.d. level of 0.1% or less at most output powers, although it is slightly higher just below the onset of clipping. Of course, as clipping commences the distortion level increases very rapidly.

The VMOS transistors specified for TR3 and TR4 are available from Maplin Electronic Supplies.

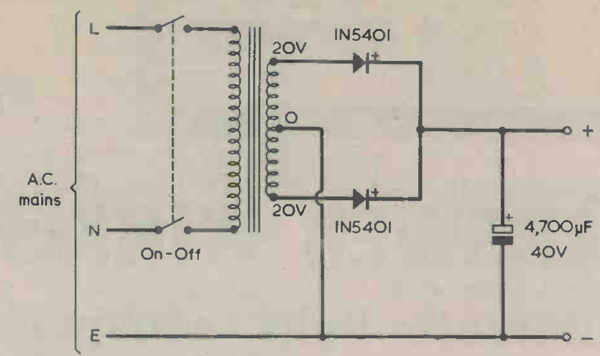



*Fig. 4. The amplifier can be supplied by a simple unstabilized power supply, having the circuit shown here, with a slight loss of r.m.s. output power*

## CONSTRUCTION

A suitable printed circuit board design for the amplifier is shown full size in Fig. 3, which illustrates both the component layout and the copper pattern.

TR3 and TR4 require a substantial amount of heatsinking, which can be provided by a large commercially made heatsink. The heat-tabs of the transistors are internally connected to the drain terminals, and so an insulating set or sets will be required if the transistors share a common heatsink. The heatsinks visible in the photographs of the amplifier are type FL57M, available from Maplin Electronic Supplies. These are just adequate with ordinary speech and music signals, but they allow the output transistors to become rather hot when running the amplifier at full power with a sine wave input.

The input leads can be unscreened if they are short and there is no risk of hum pick-up. Most constructors will prefer screened cable here, and the braiding should, of course, connect to the copper area which is common with the negative supply rail, and the centre conductor to C4. If the board is mounted in a metal case, the case should be connected to the negative rail.

The capacitor employed in the prototype for C5 was a "single-ended" type with both lead-outs appearing at one end. A normal capacitor with lead-outs at both ends may be employed instead, if desired, with the negative end nearer the board and the positive lead-out taken down the side of the component.

Before applying power to the completed amplifier, R9 should be set to insert minimum resistance into circuit. This is given when its slider is adjusted fully clockwise. A testmeter switched to a high current range (to avoid the risk of damage to the meter in case of a fault in the amplifier and also to allow for initial surge current when the electrolytic capacitors charge up) is inserted in the positive supply lead. When indications show that it is safe to do so the testmeter is switched to a range which allows a clear reading of 30mA, after which R9 slider is adjusted in an anti-clockwise direction until 30mA is indicated. The testmeter is removed and the amplifier is then ready for use.

## POWER SUPPLY

Ideally, the amplifier should be powered by a stabilized supply offering 30 volts at a mean current of at least 600mA, or 1.2 amps if two amplifiers are used in a stereo system. A non-stabilized supply can be used provided that it gives an output voltage of no more than about 32 to 33 volts under quiescent conditions.

The circuit of a suitable non-stabilized supply is shown in Fig. 4. The transformer secondary should be rated at 1 amp or more and the two diodes provide full-wave rectification. The large-valve reservoir capacitor gives a considerable degree of smoothing and there is a reasonably low ripple content on the output. A suitable mains transformer having two 20 volt 1 amp secondaries is listed in the Maplin Electronic Supplies catalogue.

Since a mains transformer usually offers slightly more than its nominal secondary voltage under low current conditions, the power supply quiescent output voltage will be slightly in excess of 30 volts, this dropping by several volts when the amplifier is fully driven by a sine wave signal. This will cause the amplifier to deliver a little less than 10 watts r.m.s. with a sine wave input, although with a normal music signal the output power will not be significantly different to that obtained when using a 30 volt stabilized supply.

The same power supply may be used for two amplifiers in a stereo system but the mains transformer secondary should then be rated at 2 amps or more. ■

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# ANSWER WINKER

## Automatic light transponder

The rather unusual circuit described in this last article in the "Double Deccer" series can be used simply as a piece of fun, but it has serious applications because the circuit is a simple type of transponder — a circuit that replies to a signal. In our circuit a light beam from a torch will, when it strikes the photocell, cause the circuit to be triggered and after a short time delay the lamp in the circuit flashes back an acknowledgement. This simple circuit shows the basic principles of transponder action, which was first extensively used in World War II for I.F.F. (Identification, Friend or Foe). With this system a transmitter on a British aircraft sent out a signal which would trigger a transponder on any other British aircraft. The transponder would then send out a coded signal on another frequency, and reception of the correct signal would cause the "friend" signal to light on the equipment. No reply would cause the "foe" warning to be flashed.

### PHOTOCELL

The circuit consists of a photocell and amplifier, a delay monostable, a signal monostable and a lamp-driver stage. The photocell is the familiar ORP12 light dependent resistor, which is connected in series with a 10k Ω variable resistor, VR1, acting as the sensitivity control. When the photocell is in darkness its resistance is high, so that TR1 is switched on and bottomed. Resistor R1 ensures that excessive current doesn't flow in VR1 or TR1 if the potentiometer is incorrectly adjusted. In darkness, therefore, the collector voltage of TR1 is very low and, since TR1 collector is directly connected to TR2 base, TR2 will be cut off. Its collector voltage is then high and is at the potential of the positive supply rail. When a beam of light strikes the photocell its resistance decreases, causing TR1 to cut off and its collector voltage to rise. This turns on TR2, causing a rapid drop in the voltage at TR2 collector.

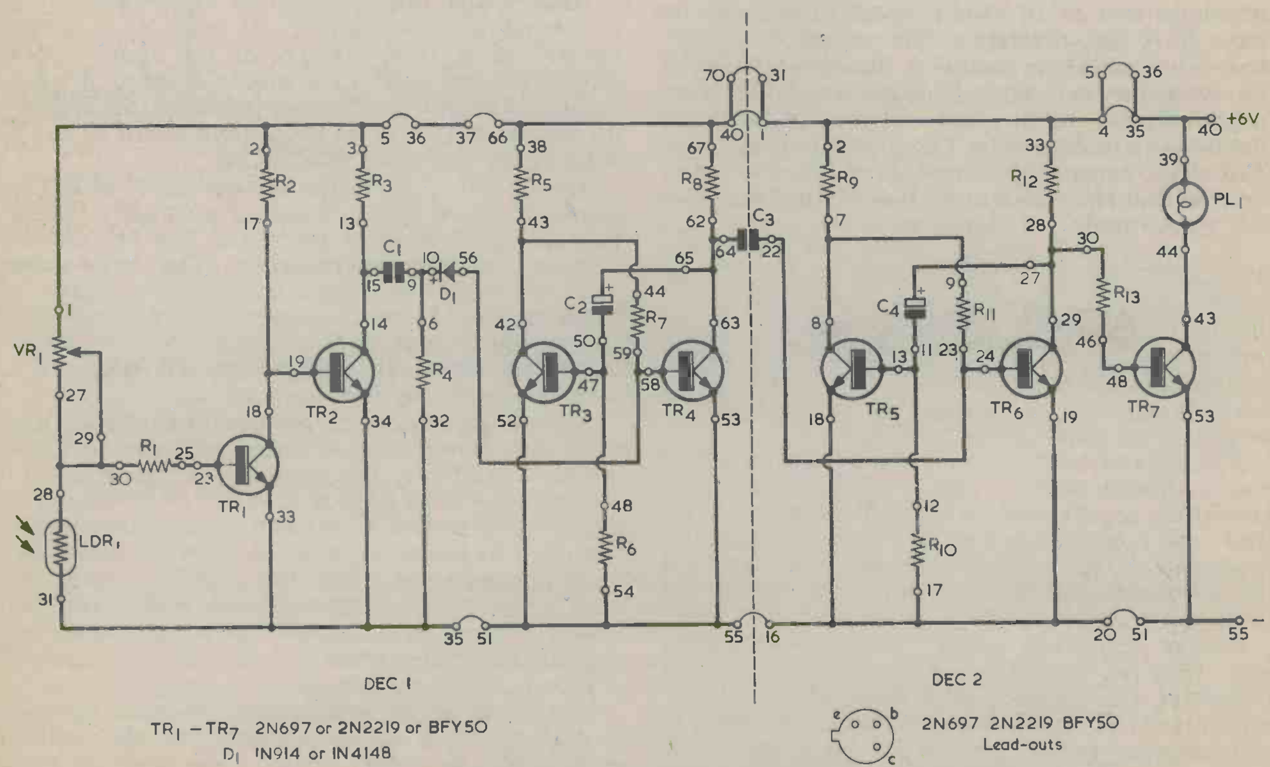



*Fig. 1. Full circuit of the answer winker. This transponds by lighting up PL1 a short time after LDR1 has been interrogated by a light beam*

Looking now at the next stage, TR3 and TR4 are connected in a simple monostable circuit. The collector of TR3 is directly coupled through R7 to the base of TR4, so that in the absence of any signals through diode D1, current flows through R5 and R7 into the base of TR4, keeping this transistor turned fully on. The collector of TR4 couples via C2 to the base of TR3. This base is normally held at the potential of the negative rail by R6, causing TR3 to be cut off. In consequence, TR3 collector is at a high voltage, keeping TR4 turned on.

A negative pulse fed into this part of the circuit from the collector of TR2 via C1 and D1 will turn off TR4, so that its collector voltage rises and takes TR3 base positive by way of C2, turning TR2 on. TR3 collector voltage becomes very low, keeping TR4 cut off. If TR2 collector should now happen to go positive it will have no effect on TR4 because D1 will then be reverse biased.

C2 charges through R8, the base-emitter junction of TR3 and R6, and when it has become sufficiently charged the base voltage of TR3 will fall sufficiently for this transistor to cut off again. Its collector voltage rises, allowing TR4 to turn on again, whereupon the charged C2 ensures that TR3 is completely cut off. The positive feedback which is present in all these switching circuits, bistable or astable, causes this changeover to be very rapid. The output of the circuit is therefore a negative-going pulse edge at the collector of TR4. The time preceding the pulse is mainly determined by the values of C2 and R8, and is only slightly affected by the value of R6. After the production of the negative-going pulse, C2 discharges via the fully turned-on TR4 and R6.

## SECOND MONOSTABLE

The second monostable stage consisting of TR5 and TR6 is identical, with TR6 being the transistor which is normally turned on. A positive-going pulse edge from TR4 collector has no effect on TR6 because it merely increases its base current due to the consequent charging current through C3. But a negative-going pulse, which appears at the end of the delay period given by TR3 and TR4, will cut off TR6. This causes the second monostable to switch over so that the collector voltage of TR6 goes high for a time mainly dependent on the values of C4


*Fig. 2. A relay coil can be connected in place of PL1. It may have an operating current of 12 to 70mA and should energise reliably at 6 volts. Also required with the relay is a protective diode, which must be connected into circuit with correct polarity*

and R12. After this period TR6 conducts again, and its collector voltage remains low until the circuit is triggered again.

With TR6 collector voltage in its normal low state no current flows in R13, and TR7 is cut off. When TR6 cuts off, current flows through R12 and R13 into the base of TR7, turning on this transistor and causing the lamp to light. As in previous Double Deccer circuits a relay could also be operated if a different type of response were wanted. The relay coil and protective diode are connected into the circuit as shown in Fig. 2.

The overall action of the complete circuit is, therefore, that a beam of light on the photocell will not produce an immediate effect but, after a short time, will cause the lamp to light. The lamp remains lit for a further short time and then extinguishes. It remains unlit until the photocell is again illuminated, after having been in darkness sufficiently long for the circuit to reset.

## CONSTRUCTION

Join the two S-DeCs together to form one long DeC, and insert all the wire links. Capacitor C3, which bridges the two DeCs, should also be inserted at this stage. The front panel of one DeC can be used to take the lampholder and VR1, and these should be connected into the DeCs using single-core wire. The photocell LDR1 can be plugged directly into the S-DeC, with short extension leads

### COMPONENTS

*Resistors*
(All fixed values ¼ watt 5%)
R1 4.7k Ω
R2 4.7k Ω
R3 4.7k Ω
R4 150k Ω
R5 1.8k Ω
R6 56k Ω
R7 56k Ω
R8 1.8k Ω
R9 1.8k Ω
R10 56k Ω
R11 56k Ω
R12 1.8k Ω
R13 4.7k Ω

VR1 10k Ω potentiometer, linear

*Capacitors*
C1 0.1μF polyester
C2 470 or 500μF electrolytic, 10V. Wkg.
C3 0.1μF polyester
C4 470 or 500μF electrolytic, 10V. Wkg.

*Semiconductors*
TR1-TR7 2N697 or 2N2219 or BFY50
D1 1N914 or 1N4148

*Photocell*
LDR1 ORP12

*Lamp*
PL1 6V 60mA, m.e.s.

*Miscellaneous*
2-off S-DeC
6V battery
Lamp holder, m.e.s.
Control knob

soldered on as necessary. Remember that stranded wire must not be inserted into the holes in the S-DeCs unless it has been tightly twisted and soldered to prevent it tangling.

The remaining capacitors and the diode D1 can now be plugged into place. The diode and capacitors C2 and C4 are all polarised components which must be connected the correct way round. The seven transistors can now be plugged into their positions, remembering that the monostables are constructed with the "mirror-image" type of layout in which the emitter leads are inserted in a centre line of the DeC. The resistors can now be added, and the answer winker is ready to transpond.

**TESTING**

Adjust VR1 so that it inserts maximum resistance into circuit and take the unit into a dimly-lit room with its light switched off. Connect the battery. There should be no response. Now shine a torch on the photocell or turn the main room light on and off briefly. After a short delay, PL1 should light and stay illuminated for a short time. If there is no response, as may happen if the torch light is not bright enough or the light is some distance from the photocell, then VR1 can be adjusted until the unit triggers on the desired signal. If the room lighting is not particularly dim, VR1 will have to be adjusted to a level where only the torch beam will trigger the circuit. Avoid adjusting VR1 so that it inserts very low values of resistance into circuit if the photocell should happen to be very brightly illuminated, say by direct sunlight. ■

# CALCULATOR TOPIC

## By Recorder

Swindling a computer appears at first sight to be an awesome task, but it seems that there are quite a few nefarious characters who profit more than adequately from hoodwinking these poor old machines. As if they haven't got enough to do as it is, sorting out all the problems with which they are presented and having nothing better than simple binary to carry out their tasks.

In America (where else?) one gentleman opened a bank account, then proceeded to take away with him a wad of paying-in slips which were left out for the convenience of the bank's customers. The next part of the story becomes a little vague, so far as the more precisely-minded amongst us are concerned, because the procedure adopted is described by non-technical newsmen. At any event, the trickster is reported as having managed to impress on the paying-in slips the magnetic coding corresponding to his own account number. He then returned the paying-in slips and left them lying around in the bank. The slips were next picked up by unsuspecting bank clients who entered on them the details of the amounts they were depositing. But when the paying-in slips were fed into the computer all the deposits were routed into the account of the swindler.

After a sizeable sum had been credited in this manner he simply withdrew a hundred thousand dollars and quietly disappeared back into the woodwork.

Many of us do not have access, either legally or illegally, to full-sized computers, but a number of us are now playing around with microprocessors, and we nearly all are the proud possessors of pocket calculators.

Is it possible for two different models of calculator to give different answers to the same problem? It quite definitely is, as I've proved to my own satisfaction with a very respectable calculator and another calculator which falls into the bargain basement category. The first calculator is the Texas Instruments Programmable TI-57 (which I acquired after Ian Sinclair's "Tune-In To Programs" series started in this journal) and the second is a much simpler calculator which was on offer at a stationer's for £6.50. That calculator was quite a bargain too, as it happened, since the price included a "mains adaptor" comprising a mains transformer and rectifier for charging the calculator battery. The inexpensive calculator adds, subtracts, multiplies and divides perfectly and, for me, has the great advantage of possessing a square root facility. I shudder to think of the hours I have wasted in the past working out square roots, either the long way or with logs, when sorting out resonant frequencies and things like that.

If I present the simple problem "2 plus 3 times 4 equals" to the Texas calculator it at once tells me that the answer is 14. And if I present the same problem to the £6.50 job it just as quickly flashes up an answer of 20! Which calculator is wrong?

It is the second calculator which is giving the wrong answer. Not, I must hasten to add, because it is producing a numerical error but simply because it does not possess the logic to deal with mixed additions and multiplications.

When you are confronted with a problem containing additions, subtractions, multiplications and divisions, the multiplications and divisions *must* be completed first before tackling the additions and subtractions. So, with the problem "2 plus 3 times 4 equals" the correct sequence is to multiply 3 by 4, to give 12, and then add the 2, resulting in an answer of 14. The powerful TI-57 has what is described by Texas as "AOS" (which stands for Algebraic Operating System) and the AOS circuits sort out all the multiplications and divisions before even starting on the additions and subtractions.

Not so with the low cost calculator. This inexpensive machine merely does the last thing it has been told to do. When presented with "2 plus 3" its little brain chugs away and produced the answer, 5. If it is next told "times 4 equals", it says to itself: "Well, I've got 5 stored away in my little memory, so if the Master wants this multiplied by 4 I'll do just that for him. No problem." And, obligingly, it displays the number 20.

All this shows that you have to take a little care when working out problems with the more inexpensive type of calculator. If it can't sort out the heirarchy of multiplications, divisions, additions and subtractions, then you have to do the sorting out for it by getting the multiplications and divisions out of the way first. If you present our little problem in the form "3 times 4 plus 2", even the most elementary electronic calculator should give you the correct solution of 14. ■

# THE "DORIC" 9 WAVEBAND PORTABLE

## Part 3

By Sir Douglas Hall, Bt., K.C.M.G.

### Initial steps in constructing the a.m.-f.m. tuner.

Next follows the medium, long and v.h.f. tuner part of the complete "Doric" receiver. This tuner may be employed as a receiver on its own, feeding a pair of standard 8  stereo headphones, or it can be coupled to the amplifier and short wave receiver assembly to produce a comprehensive receiver covering the short wave bands, medium and long waves, and v.h.f. band II.

## CIRCUIT DIAGRAM

The circuit of the tuner is shown in Fig. 7, and in this TR7 and TR8 form the reflexed v.h.f. section, and TR5 and TR6 the reflexed medium and long wave section. Both sections use a common emitter follower to couple their outputs to the stereo phones or to the amplifier and short wave receiver

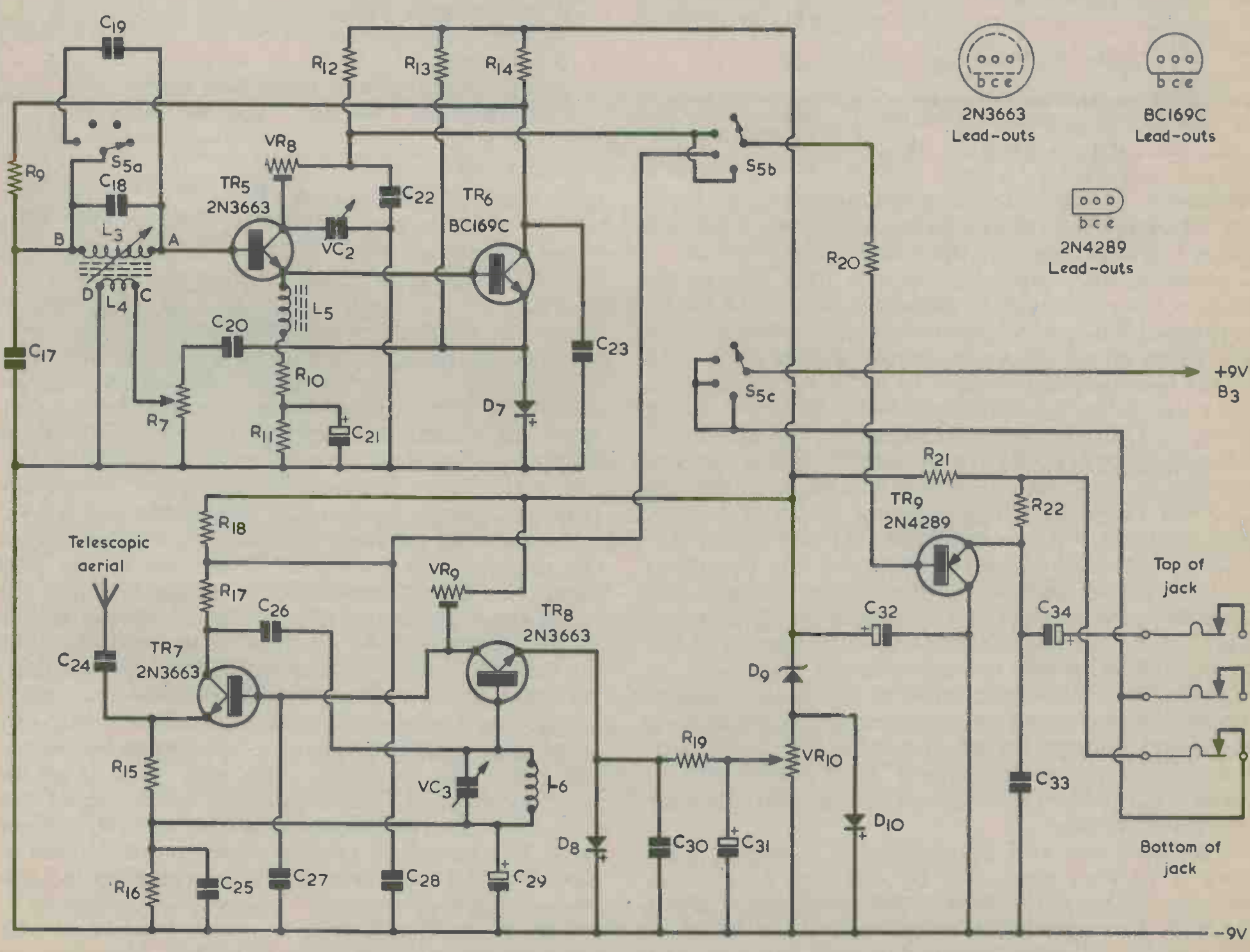



*Fig. 7. The circuit of the v.h.f. and medium and long wave tuner. Potentiometers VR7 and VR10 are ganged*

## COMPONENTS

*Resistors*
(All fixed values ¼ watt 10%)

| | |
|---|---|
| R9 10kΩ | R16 3.9kΩ |
| R10 22Ω | R17 1kΩ |
| R11 6.8kΩ | R18 18kΩ |
| R12 15kΩ | R19 1.2kΩ |
| R13 39kΩ | R20 27kΩ |
| R14 47kΩ | R21 1.5kΩ |
| R15 220Ω | R22 3.9kΩ |

VR7, VR10 4.7k +4.7kΩ dual potentiometer, linear, type JP20 (Electrovalue)
VR8 22kΩ pre-set potentiometer, 0.25 or 0.3 watt, horizontal
VR9 220kΩ pre-set potentiometer, 0.25 or 0.3 watt, horizontal

*Inductors*
L3, L4 see text
L5 2.5mH r.f. choke (Repanco)
L6 see text

*Semiconductors*
TR5 2N3663 (Electrovalue)
TR6 BC169C
TR7 2N3663
TR8 2N3663
TR9 2N4289
D7 OA10
D8 OA90 or OA91
D9 BZY88C6V2
D10 1S44

*Switch*
S5 3-pole 4-way rotary, miniature

*Socket*
Stereo jack socket (see text)

*Capacitors*
C17 1,000pF silvered mica or ceramic
C18 47pF silvered mica or ceramic
C19 680pF silvered mica or ceramic
C20 0.01μF polyester
C21 22μF electrolytic, 3V. Wkg.
C22 1,000pF silvered mica or ceramic
C23 1,000pF silvered mica or ceramic
C24 100pF silvered mica or ceramic
C25 1,000pF silvered mica or ceramic
C26 2.2pF silvered mica or ceramic
C27 1,000pF silvered mica or ceramic
C28 1,000pF silvered mica or ceramic
C29 100μF electrolytic, 10 V. Wkg.
C30 6.8pF silvered mica or ceramic
C31 220μF electrolytic, 3 V. Wkg.
C32 100μF electrolytic, 10 V. Wkg.
C33 1,000pF silvered mica or ceramic
C34 220μF electrolytic, 10 V. Wkg.
VC2 20pF mica trimmer
VC3 15pF variable, type C804 (Jackson)

*Aerial*
Telescopic aerial type TA10 (Eagle-Electrovalue)

*Miscellaneous*
28-way tagstrip (see text)
6:1 ball drive type 4511/F (Jackson)
3 control knobs
Ferrite rod (see text)
9-volt battery type PP3
Battery connector
Nylon cord
Aerial brackets and clips (see text)
Materials for case and "chassis" assembly

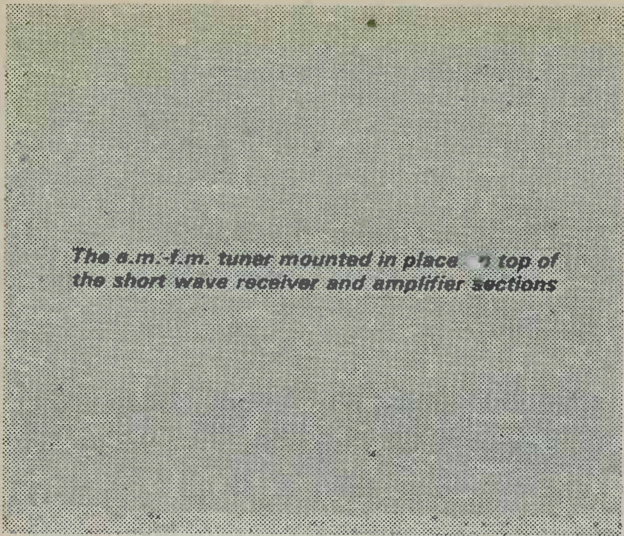
assembly. In the latter case the output signal from the present receiver is linked to the amplifier via the a.f. transformer in the short wave receiver.

Dealing with the v.h.f. section first, the signal from a telescopic aerial passes through C24 to the emitter of TR7, which functions as a common base amplifier at r.f. with the output across R17. The signal then passes via C26 to TR8, operating as a common collector amplifier, with detection being given by D8. The detected signal is then amplified once more by TR8 in the common base mode and applied to TR7 base. C30 acts as a capacitance tap into the tuned circuit consisting of L6 and VC3, and it causes TR8 to oscillate gently at signal frequency and thus allow synchronous f.m. detection to take place. Direct current flows through D8, both from the emitter of TR8 and from the slider of VR10. VR10 is set to reduce the impedance of D8 to a point where a correct state of oscillation is maintained. D10 maintains a stabilized voltage across VR10, and in company with D9 provides a stabilized voltage for all the other reflexed transistors. Pre-set potentiometer VR9 is adjusted to bring TR8 to the required operating conditions for correct oscillation.

The detected and amplified a.f. signal at TR7 base is further amplified by TR7 as a common emitter device with some negative feedback given by R15. The signal finally passes to TR9, which is the emitter follower common to both the a.m. and f.m. tuner sections. TR9 has a low output impedance, and its output is coupled to the upper contact of the stereo jack socket.

The latter is an insulated ¾in. type with three break contacts, such as the Electrovalue type S3BBB. This type of socket has the normal ¼in. aperture at the bush mounting end, but there is also a ¼in. aperture at the other end. The receiver is arranged so that, if the jack plug of a pair of stereo headphones is inserted at the correct end of the socket, it only makes contact at the top 2 contacts, as illustrated in Fig. 7. The two stereo earphones are then connected in series to the output of the tuner. Since the plug does not reach the bottom contact, the 9 volt positive supply is not interrupted and the receiver is switched on and off in the normal way by S5(c). When the stereo plug from the "Doric" amplifier is passed through the top of the amplifier case into the *bottom* of the jack socket, it connects to all three contacts and allows the receiver output to be coupled into the amplifier input via the transformer in the short wave receiver section, and also enables the on-off switch in the amplifier to control the a.m.-f.m. tuner by way of the lower two contacts. The jack plug must be securely pushed home, and the thickness of the a.m.-f.m. receiver base gives the right clearance here. The a.m.-f.m. receiver must be turned off at its own switch when the short wave receiver is turned on, and vice versa.

The medium and long wave section is given by the circuitry around TR5 and TR6. The signal is picked up by L3, which has its inductance varied by a moving ferrite rod. The tuning capacitance is



*The a.m.-f.m. tuner mounted in place on top of the short wave receiver and amplifier sections*

provided by C18 on medium waves and by C18 and C19 in parallel on long waves. TR5 and TR6 forma "super alpha" pair and detection takes place at D7. This is a low impedance diode whose impedance is made even lower by the direct current flowing through it via R13. TR6 gives a.f. amplification in the common base mode, the a.f. signal at its collector passing through R9 and coil L3 to the base of TR5, which gives further amplification as a common emitter device. Positive feedback for reaction is given by L4, and is controlled by VR7. This potentiometer is ganged with the v.h.f. feedback control, VR10. The a.f. signal is finally passed to the emitter follower, TR9. VR8 is adjusted to maintain a constant setting in VR7 between about 250 and 500 metres on the medium wave band. A constant setting below 250 metres is achieved by adjustment of the trimmer VC2.

## CONSTRUCTION

Construction commences by cutting out the items in Figs. 8 (a), (b), (c), (d), (f), (g), (h) and (j). Two 4BA bolts on either side of the ¼in. hole in Fig. 8(a) take countersunk 4BA bolts which hold the stereo jack socket in place with the aid of the item of Fig. 8(j), as shown in Fig. 8(k). The two 4BA clear holes in Fig. 8(j) match the corresponding holes in Fig. 8(a). Two further 4BA clear holes (C and D) are intended for the telescopic aerial holding assembly in Fig. 8 (l) and the aerial swivel assembly in Fig. 8(m). The two remaining 4BA clear holes in Fig. 8(a) are marked out later with the aid of an item which is not yet prepared. Also required in Fig. 8(a), but not shown in the diagram, is a ½in. hole for the short wave telescopic aerial.

The lower edge of Fig. 8(a) corresponds with the front edge of the receiver when it is fitted on top of the amplifier and speaker section. Position the item of Fig. 8(a) on top of the amplifier case with the front of the ½in. "feet" flush with the amplifier front and the sides flush with the amplifier sides. Mark out the centre of the ¼in. hole on the lid of the amplifier case, remove the item of Fig. 8(a), then drill a hole in the amplifier case lid ⅝in. in diameter. This accepts the body of the amplifier stereo plug, which passes up into the bottom of the stereo socket.

Place the item of Fig. 8(a) on the amplifier case lid once more and use it to mark out the centres of the two 6BA clear holes on the case lid. Drill these two holes 6BA clear in the lid. The holes will later take 6BA bolts which pass through the lid and the item of Fig. 8(a), with 6BA terminal nuts on the top, thereby securing the a.m.-f.m. tuner to the case when construction of the tuner has been completed. Finally, with the aid of the amplifier case and the short wave receiver section, locate and mark out the centre of the ½in. hole required in Fig. 8(a) to allow the passage of the short wave telescopic aerial. Drill out this hole in the Fig. 8(a) item.

The pieces of Fig. 8(b), (c) and (d) are screwed together to provide the mounting for VC3 and its epicyclic tuning drive which is shown in Fig. 8(e). The ¼in. rebate in Fig. 8(c) allows room for the body of the drive. The item of Fig. 8(c) is held against the item of Fig. 8(a) by the 1¾in. countersunk 4BA bolt of the telescopic aerial holding assembly. See Fig. 8(1).

The items of Figs. 8(f), (g) and (h) are screwed together in a similar manner to produce the assembly of Fig. 8(i). Note that the assembly leaves room for the PP3 battery, as indicated. The 1¾in. countersunk 4BA bolt for the telescopic aerial swivel assembly, shown in Fig. 8(m), passes

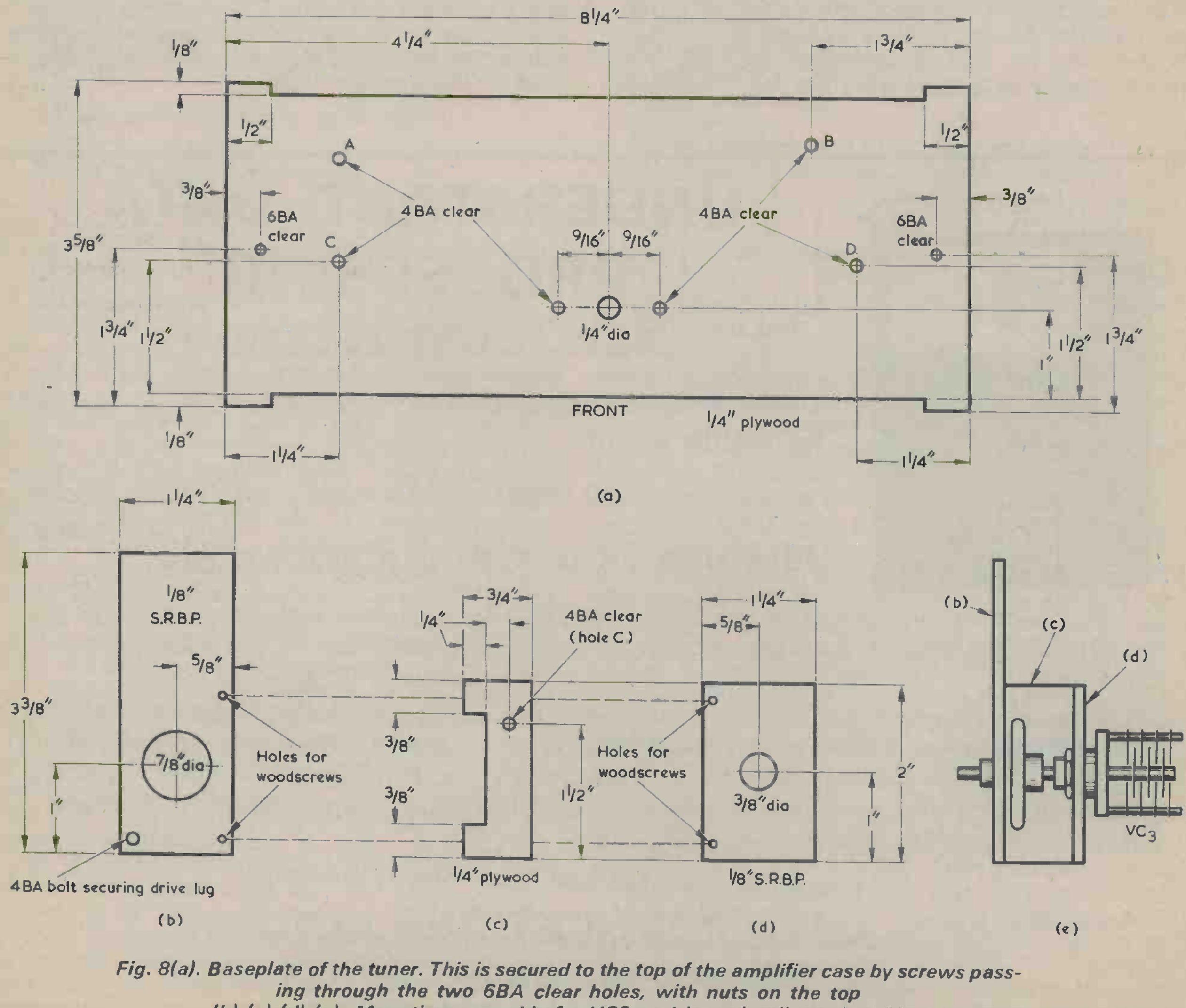



*Fig. 8(a). Baseplate of the tuner. This is secured to the top of the amplifier case by screws passing through the two 6BA clear holes, with nuts on the top*
*(b) (c) (d) (e). Mounting assembly for VC3 and its epicyclic tuning drive*

through the items of Figs. 8(g) and (a) as illustrated.

The s.r.b.p. piece of Fig. 8(j) has the outside dimensions shown. The central hole takes the mounting bush of the stereo jack socket. The two remaining holes are 4BA clear and match up with the corresponding 4BA clear holes in Fig. 8(a). When fitting the socket to Fig. 8(a), pass a plug through the ¼in. hole into the socket to ensure that the socket is located correctly. The assembly is illustrated in Fig. 8(k).

The clips and angle brackets in the assemblies of Figs. 8(l) and (m) were Lektrokit type LK2721 and LK2311 in the prototype, but Lektrokit parts are difficult to obtain on the home constructor market at the time being. The clips are ⅜in. types whilst the brackets have dimensions of ½in. by ⅞in. by ⅜in. The brackets may be home-made from thin metal strip and suitable Terry clips or similar may be obtained from hardware stores. The base of the telescopic aerial fits into the clip of Fig. 8(m), the nuts here being tightened such that the aerial can be swivelled in any direction. When not in use, the aerial is fitted into the clamp of Fig. 8(1) and may then be used as a carrying handle.

## COILS

The coils are made next, starting with L6. Cut a length, 1⅜in. long, from the outer case of a "Bic" ball-point pen. Drill two 1/16in. holes in it, each 3/16in. from an end. Wind on 6 turns of bare tinned copper wire, the turns being equally spaced, and pass the ends of the coil through the 1/16in. holes to anchor them. See Fig. 9(d). The wire should be approximately 22 s.w.g., and normal wiring-up wire stripped of its insulation will do nicely. Ignore the two half-turns given by the wire passing through the two end holes.

L3 and L4 require a 3in. ferrite rod of ⅜in. diameter, and this is obtained by cutting down a 4 or 4½in. orange grade ferrite rod obtained from Amatronix. Details of cutting down the rod were given in Part 1 of this series. The two windings are made up in a similar manner to the coil which was used for the short wave receiver, also described in Part 1. Make a tube of Fablon by cutting out a piece 4 by 3½in., and remove the backing paper over a strip ½in. wide along one 3½in. side. The Fablon is wrapped around the ferrite rod so that the exposed adhesive comes on last and secures the

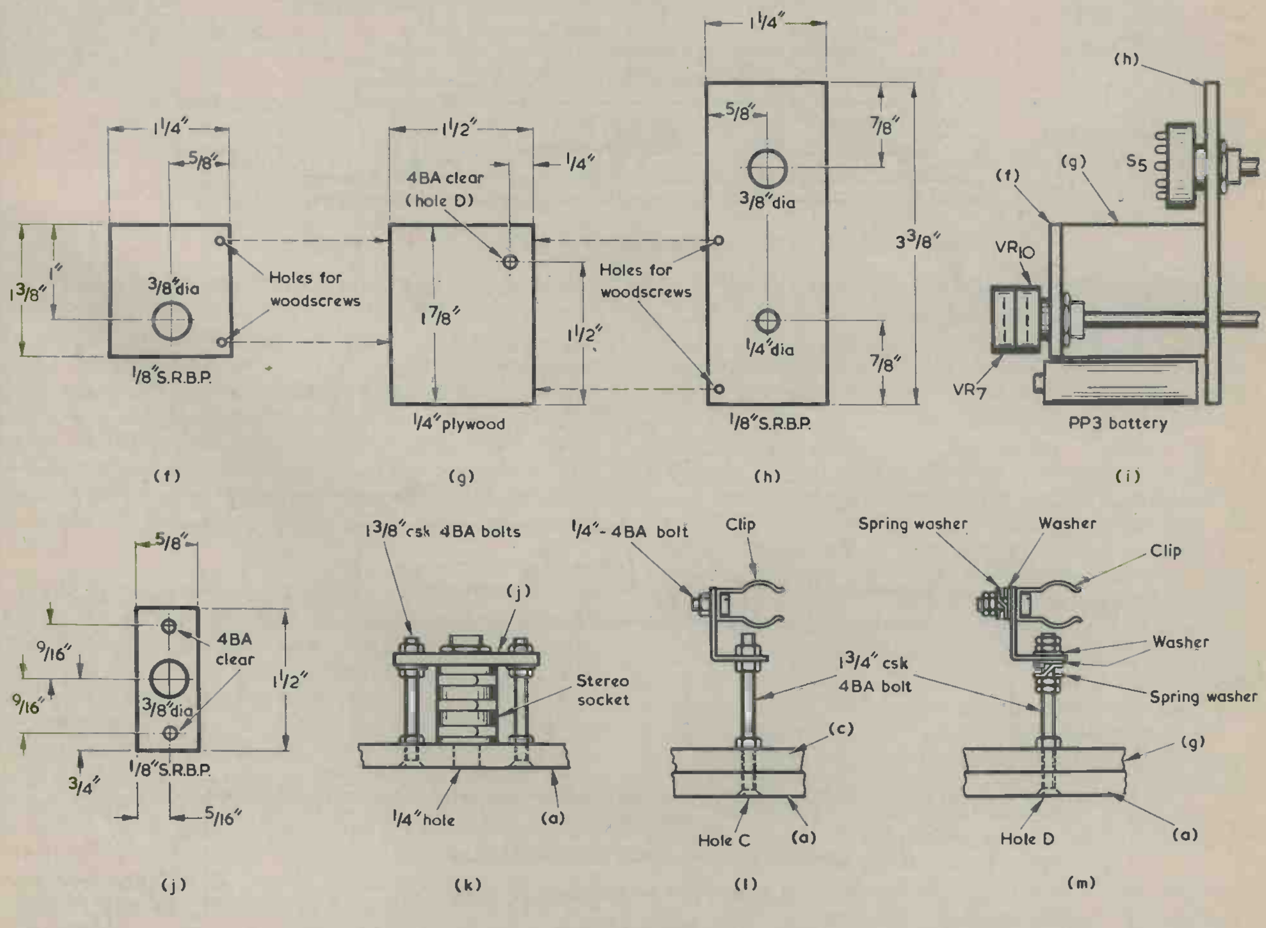



*Fig. 8(f) (g) (h) (i). A similar form of mounting assembly is employed for the dual potentiometer VR7/VR10 and S5*

*(j). Mounting item for the stereo jack socket*

*(k). The socket is secured to the baseplate as shown here*

*(l). Telescopic aerial clip assembly*

*(m). The swivelling clip, into which the base of the telescopic aerial is fitted*

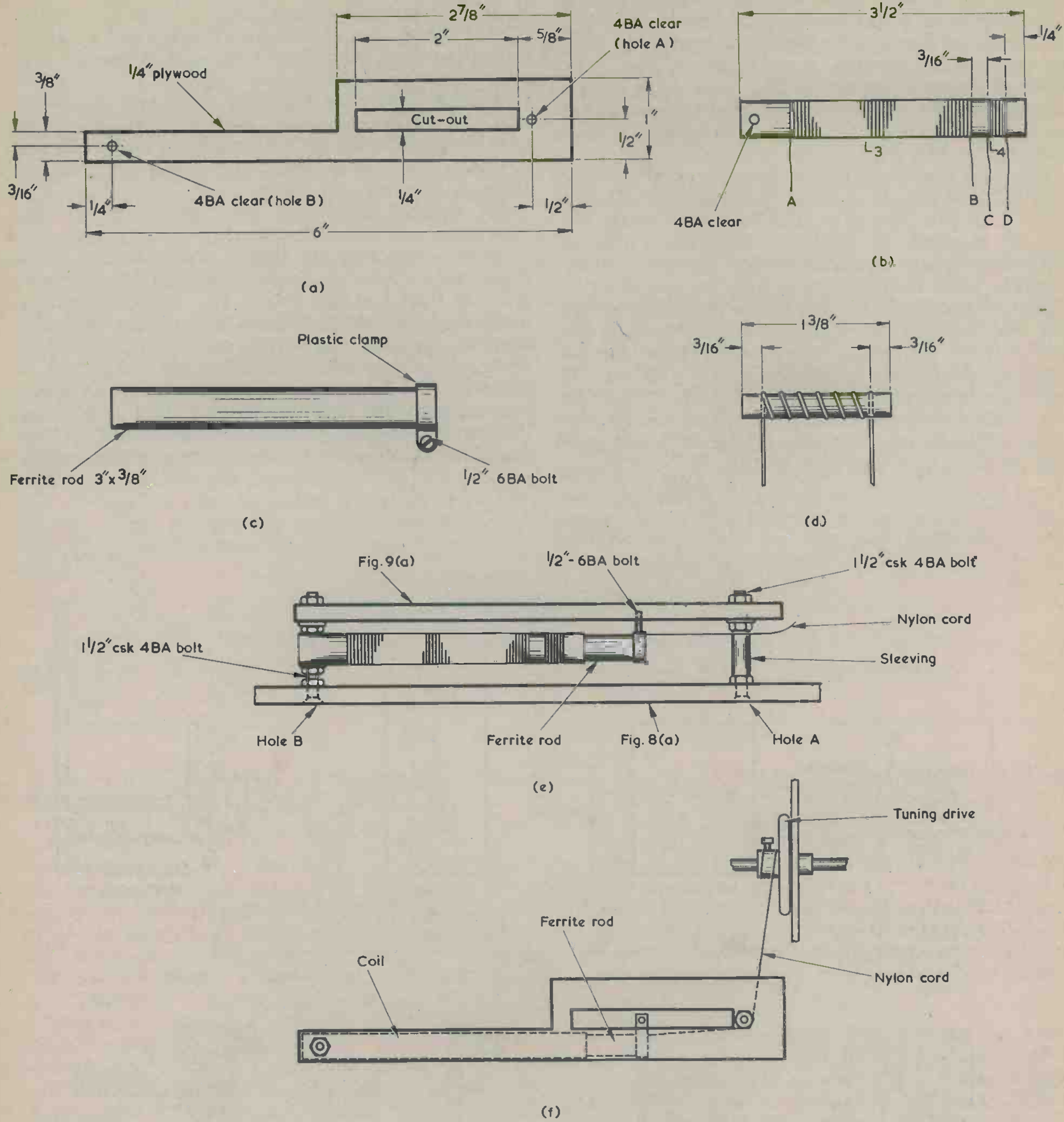



*Fig. 9(a). Plywood item which is fitted above the medium and long wave coil and ferrite rod assembly*

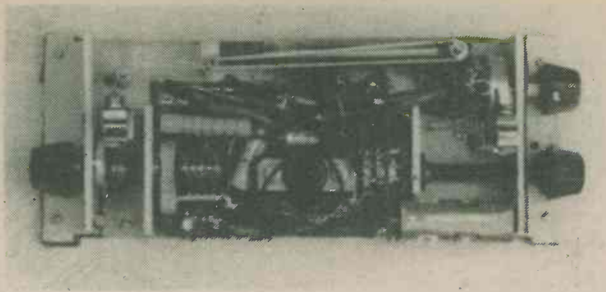
*(b). Details of the medium and long wave coil*

*(c). The ferrite rod and its plastic clamp*

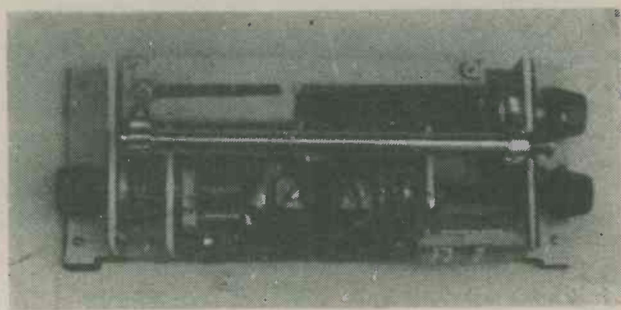
*(d). The v.h.f. coil*

*(e). View from the rear of the receiver illustrating the operation of the ferrite rod. Omitted, for clarity, is the rubber band which draws the rod into the coil*

*(f). Top view, illustrating the nylon cord linkage to the epicyclic tuning device*



*The tuner, as assembled without the item of Fig. 9(a)*



*Here, the Fig. 9(a) item has been fitted, as also has the telescopic aerial*

tube. The ferrite rod should be able to slide easily in the tube, but without wobble. A $\frac{1}{2}$in. length of $\frac{3}{8}$in. wood dowelling is inserted at one end of the tube, having had a turn or two of Sellotape wrapped around it to make a snug fit. A 4BA clear hole is drilled through the tube and dowelling at the centre of the latter. Insert the rod and wind on L3 and L4 as indicated in Fig. 9(b). L3 consists of 220 turns of 34 s.w.g. enamelled wire, and L4 consists of 15 turns of the same wire. Both coils are close-wound.

Next cut out the item shown in Fig. 9(a). This will be fitted to Fig. 8(a) in the manner shown in Figs. 9(e) and (f). The view in Fig. 9(e) is from the rear of the receiver, and the nearer edge of Fig. 9(a) is directly above the nearer edge of Fig. 8(a). Use the item of Fig. 9(a) to mark out the remaining two 4BA clear holes in Fig. 8(a). Fit two 1$\frac{1}{2}$in. countersunk 4BA bolts to these holes and secure with nuts. Pass a piece of plastic sleeving over one of the bolts, as in Fig. 9(e), and add another nut. Pass a second nut over the other 4BA bolt, then the end of the coil tube and another 4BA nut. Put a rubber band over the bolt, keeping it clear of the other parts for the time being.

Take up the item of Fig. 9(a), lightly countersink the two holes in it on the upper side, then pass it over the two bolts and fit two further nuts on top. Cut out a piece of pliable plastic, 1$\frac{1}{4}$ by $\frac{1}{4}$in., and make two 6BA clear holes in it near its ends. Secure it around the end of the 3in. ferrite rod by passing a $\frac{1}{2}$in. 6BA bolt through the holes and fitting this with a 6BA nut, whereupon the plastic functions as a clamp. Tie a length of nylon cord to the plastic clamp and tighten this up on the ferrite rod. Insert the rod in the coil tube and stretch the rubber band over the 6BA bolt at the dowelling end of the tube and the 6BA plastic clamp screw. Tighten up all the nuts shown in Fig. 9(e) so that the assembly is as in the diagram. The ferrite rod is moved inside the tube by the nylon cord, which passes over the plastic sleeve and is then anchored to the epicyclic drive, as shown in Fig. 9(f). The grub screw in this drive is replaced by a standard size screw to enable the cord to be anchored to it. The end of the 6BA screw in the plastic clamp now slides inside the 2in. slot in the item of Fig. 9(a) and acts as a tuning posite plastic clamp now slides inside the 2in. slot in the item of Fig. 9(a) and acts as a tuning position indicator. Arrange matters such that the VC3 is approximately at half-capacitance when this pointer is at the end of its travel. The rubber band ensures that the ferrite rod is drawn into the coil tube as the tuning control is turned anti-clockwise.

The a.m.-f.m. receiver requires a 28-way tagstrip and this is an RS Components "Miniature" tagstrip, with a length of 194mm, which is mounted flat onto the surface to which it is fitted. Notes on obtaining RS Components products were given at the end of Part 1 of this series. A suitable alternative to the RS Components item is a 28-way tagstrip with 0.25in. tag spacing which is available from Electrovalue.

*(To be concluded)*

# 'NOTES FOR NEWCOMERS'

# LOG and LIN

## By D. Smith

### THOSE MYSTERIOUS POTENTIOMETER CLASSIFICIATIONS

As anyone who has glanced through components lists in constuctional magazines or has scanned the goods offered in mail-order catalogues will be aware, potentiometers come mainly in two types, log and linear. The latter term is frequently abbreviated to "lin".

Why are there these two categories? If we look into the subject we will find that linear potentiometers are very easy to understand whilst the reasons for using log potentiometers are rather more complicated. However, it is not too difficult to obtain a basic understanding of the necessity for log potentiometers, and this we shall do in the present short article.

#### LINEAR POTS

Linear potentiometers are components in which the percentage of track resistance tapped off by the slider varies directly with the rotation of the potentiometer spindle. If we draw a curve of resistance plotted against effective spindle rotation we get the straight line shown in Fig. 1. At 100% of spindle rotation the slider taps off all the track resistance, at 75% it taps off three-quarters, at 50% it taps off one-half, and at 25% it taps off one-quarter.

Linear potentiometers are used in applications where it is acceptable for the resistance tapped off to vary directly with spindle rotation. There are very many of these applications, ranging from the zero-set potentiometer in a multimeter (where it is actually used as a variable resistor) to the brightness control in a monochrome television receiver (where the potentiometer varies the bias voltage applied to the grid of the cathode ray tube).

Log potentiometers are more specialised components and are primarily intended for use as audio volume controls in radio receivers, television receivers and a.f. amplifiers. They function by having an audio signal applied across the track, the slider then tapping off a proportion of the signal which is passed to the following a.f. stage.

#### GEOMETRIC RESPONSE

The human ear has an approximately geometric response to the intensity of sounds. If we double the intensity of a sound we may say that we perceive an increase in its volume level. To obtain a further perceived equal increase in volume we have to double the sound intensity once more. For a third apparently equal increase in volume, as heard by the ear, the sound intensity has to be doubled yet again. So, for three *perceived* equal increases in sound volume we have actually increased the sound intensity by 2, then 4 and then 8 times.

Assuming that the sound intensity from the associated amplifier is equal to the resistance tapped off by a potentiometer employed as a

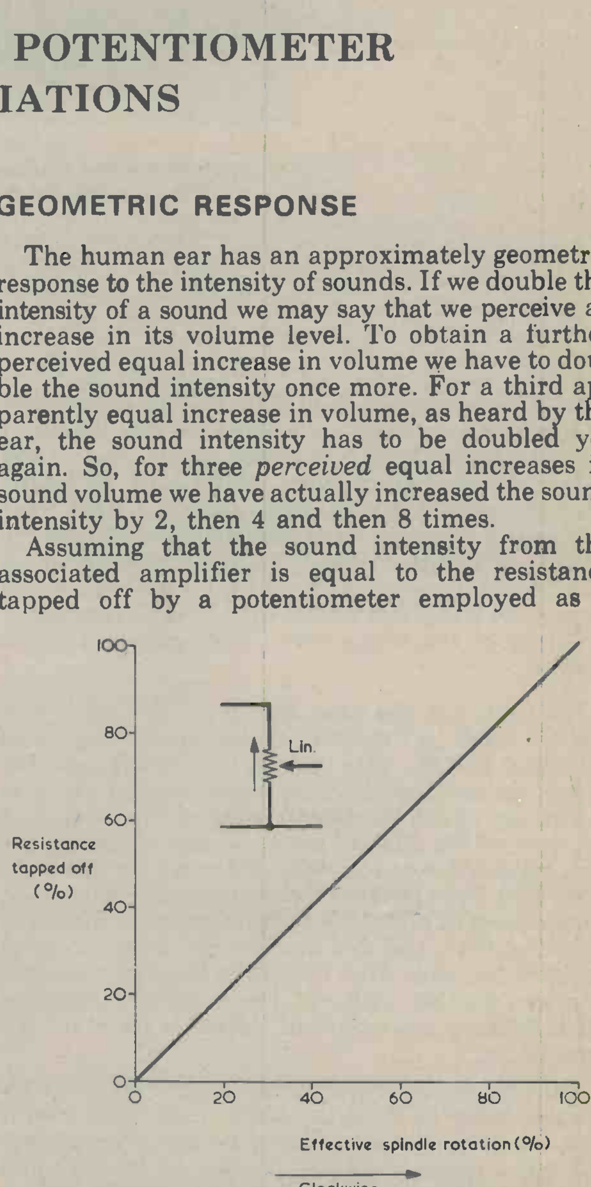
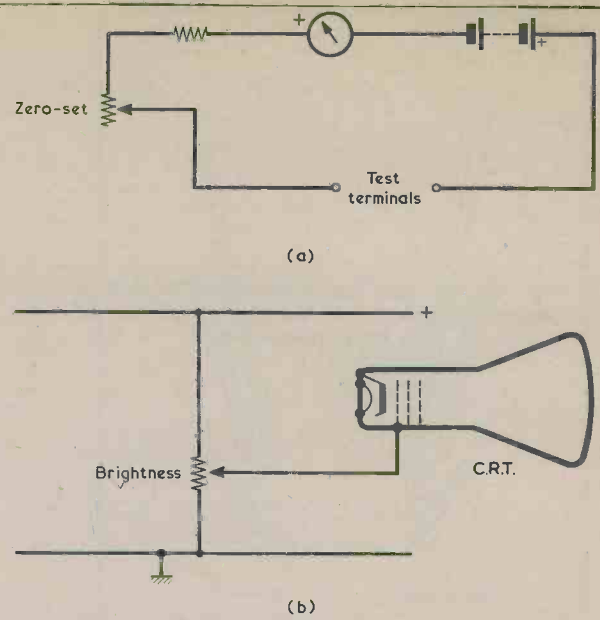



*Fig. 1. Characteristic curve showing resistance tapped off plotted against effective spindle rotation for a linear potentiometer*

*Fig. 2(a). One of the numerous applications for a linear potentiometer is as the zero-set control in an ohmmeter (b). A linear potentiometer may function as the brightness control in a monochrome television receiver. The tube cathode will be held at a positive voltage by its signal input circuit*




volume control, the effect of using a linear potentiometer as a volume control is shown in Fig. 3. In this diagram the line representing percentage of effective spindle rotation is divided into "equal units of perceived volume change". One unit is from 100% to 50%, the next is from 50% to 25%, the next from 25% to 12.5%, and so on until the units become too small and crowded to be conveniently drawn in the diagram. It will obviously be difficult to adjust the potentiometer satisfactorily at low volume levels.

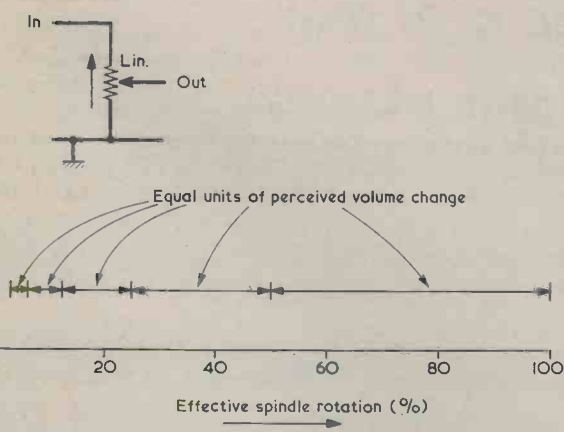



*Fig. 3. Assuming that sound intensity is equal to resistance tapped off, a linear potentiometer employed as a volume control gives the effect shown here*

## LOG TRACK

This is where the log potentiometer comes into use. Fig. 4 shows a typical curve for a log potentiometer and it will at once be seen how it functions. At the anti-clockwise end of the curve, the spindle has to be rotated by a large amount for only a small increase in the percentage of resistance tapped off. Indeed, the spindle has to be rotated to about 80% of its fully clockwise setting before the tapped off resistance reaches 50%. All the crowded "equal unit" sections in Fig. 3 therefore become opened out, allowing the control of volume to be much smoother, particularly at the low volume end of the spindle rotation range. The term "log" arises because, roughly, the spindle rotation has a logarithmic relationship with the resistance tapped off.

You won't blow any fuses by using a linear potentiometer as a volume control, and if you're experimentally minded you might like to try it out in practice. You'll then find you get the effect shown in Fig. 3.

Log potentiometers are employed in other applications where their tapered characteristic gives an apparent smoothness of control. They are,

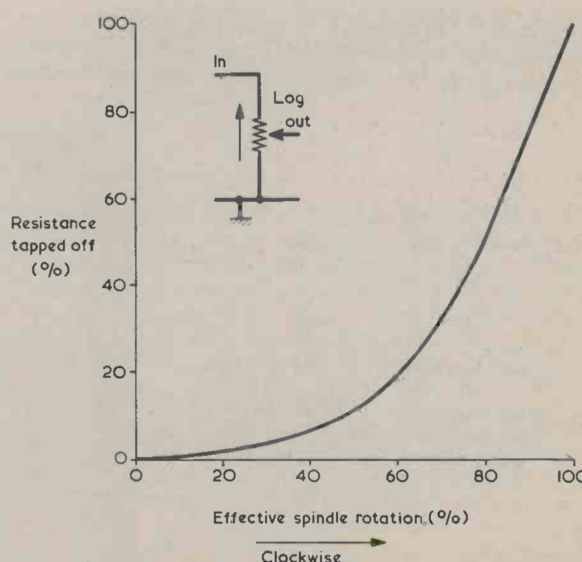
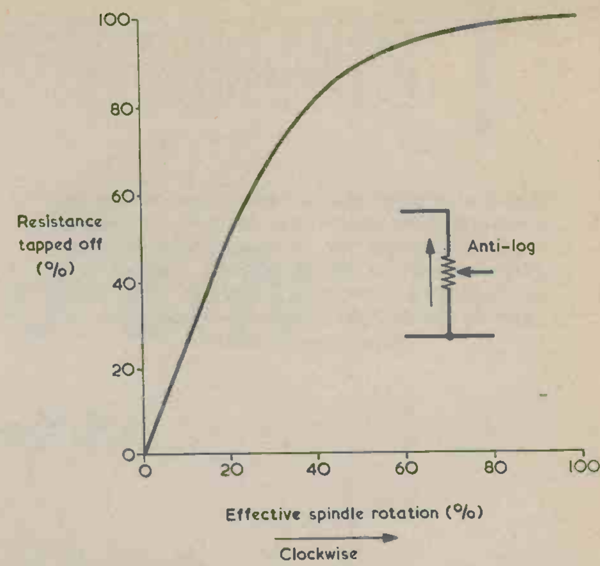



*Fig. 4. Typical track characteristic for a log potentiometer*

Fig. 5. *An anti-log potentiometer has a characteristic which is the reverse of that for the log potentiometer*



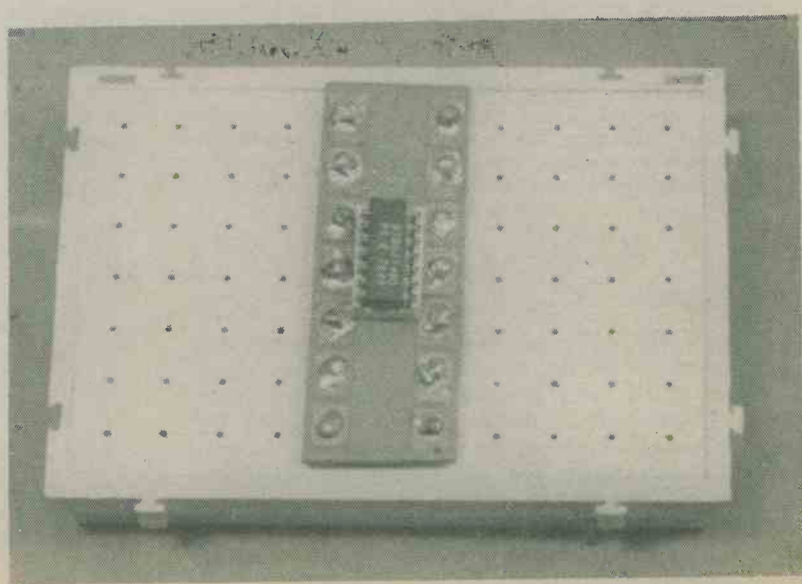

for instance, quite often encountered in tone control circuits. There are, also, anti-log potentiometers. These have a track characteristic which is the opposite of that shown in Fig. 4, and a typical example is given in Fig. 5.

# S-DEC ADAPTOR

## By
## A. M. Williams and K. R. Nash

### Home-made adaptor extends usefulness of S-DeC breadboard.

The S-DeC is one of the most popular and inexpensive breadboards presently available. However, it suffers from the disadvantage that its contact spacing is such that it will not accept d.i.l. integrated circuits. This short article describes a simple adaptor which plugs into an S-DeC and accepts



*The i.c. adaptor in use. It is fitted to the centre vertical rows of contact holes in the S-DeC and can accept 8 or 14 pin d.i.l. integrated circuits*

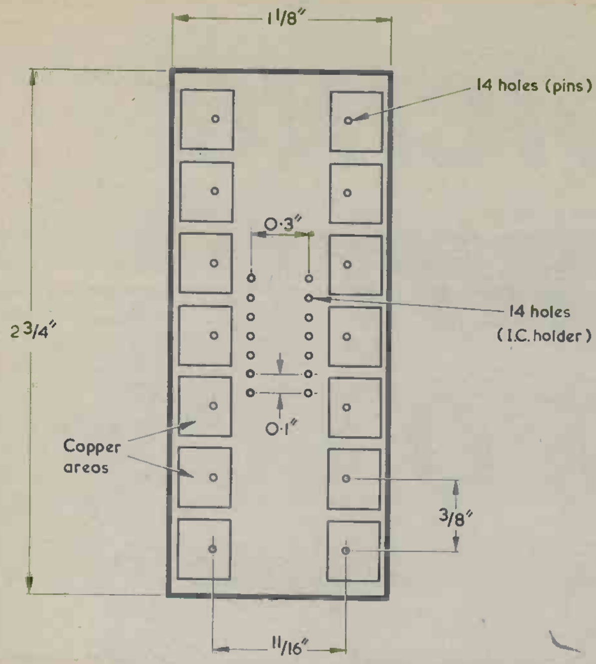



*Fig. 1. The copper pattern and holes required in the printed circuit board employed for the adaptor*

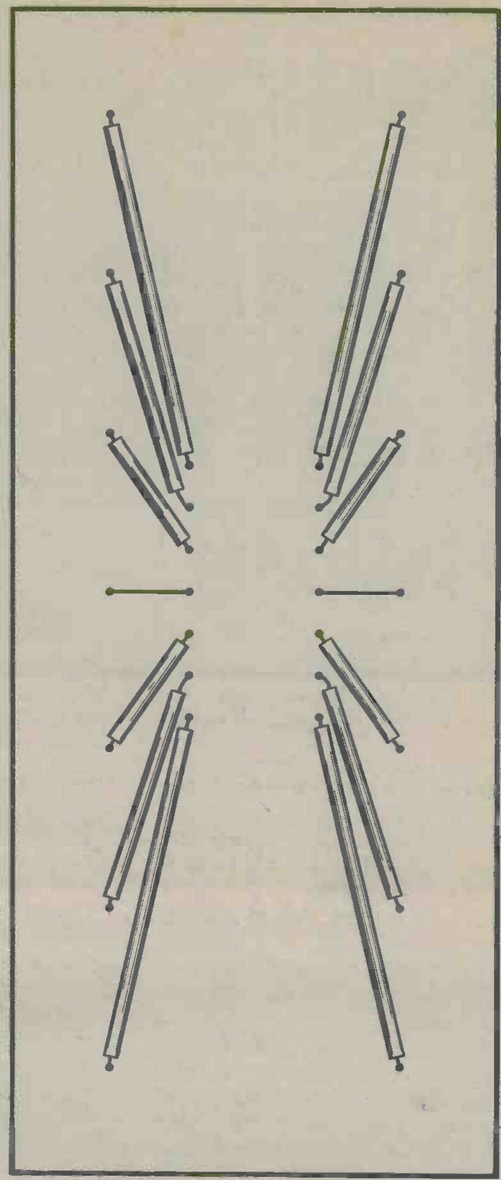


*Fig. 3. Final wiring of the i.c. holder leads to the pins. This wiring is carried out on the non-copper side of the board*

standard 8 and 14 pin i.c.'s.

## CONSTRUCTION

The adaptor is made up with a piece of printed circuit board, a 14-way i.c. holder and 14 ordinary domestic pins.

First, cut out the printed circuit board to the outside dimensions shown in Fig. 1, which is reproduced full size. Then, using standard printed circuit procedure, etch away the copper so that the 14 copper areas shown in the diagram are left. Next, drill out 14 holes in the copper areas at the positions shown, the hole diameters being such that the pins are a fairly firm fit in them. Then drill out the 14 holes in the centre of the board to take the leads of the 14-way d.i.l. holder.

Cut each pin so that its length is a little less than ½in. Place the board over an S-DeC, copper side up, and pass the pins through the board into the centre two rows of contact holes in the S-DeC. These are the vertical rows of holes from 5 to 35, and 36 to 66. Push each pin fully home, then solder its head to the copper area through which it passes. The soldering is shown in Fig. 2, and it causes each pin to be firmly held in position.

Remove the board from the S-DeC and fit the i.c. holder to the holes drilled for it. Then, on the non-copper side of the board, wire up the holder leads to the pins as shown in Fig. 3. The two centre leads and pins are connected by bare wire, and the remainder by thin insulated wire. The solder joints at the pins are kept close to the surface of the board. The adaptor is then complete and ready for use.

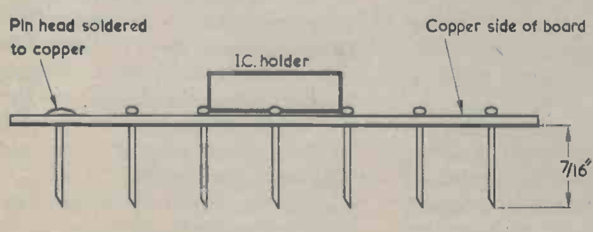



*Fig. 2. Side view illustrating the method of assembly. In practice, the i.c. holder is fitted to the board after all the pin heads have been soldered to their copper areas*

In your workshop

# DICING WITH TWO I.C.s

**Sometimes you can get too technical . . .**

"D'you know something, Smithy?"

Smithy leaned back comfortably on his stool and turned his head to look at his assistant.

"No," he replied. "What should I know?"

"That, just for once," stated Dick, "I'm getting a bit fed up with continual servicing."

"Well, that's a surprise coming from you," commented Smithy. "Normally you're pestering me all day long with questions about nothing else except repairing radios and TV's."

"Perhaps that's true," conceded Dick, "but we do now and again have a break from servicing. Like, for instance, when we make up electronic gadgets and things like that."

## ELECTRONIC DICE

"Now, it's funny you should mention that," said Smithy, "because it so happens that I've very nearly completed the construction of another little design I dreamed up over the last week or so. It only needs a few more connections to be made to it, and I intended doing these this evening."

He glanced at the Workshop clock.

"There's twenty minutes of lunch-break left," he went on, "so I might as well complete my gadget now. If I haven't made any mistakes and it works first go, I'll be able to demonstrate it to you."

He switched on his soldering iron, then reached into the cupboard under his bench and drew out a few sheets of notepaper and a small Veroboard panel. He placed the panel on a clean part of his bench, and spread out the notepaper sheets in front of him. These bore circuit diagrams and tables which had obviously been drawn up by Smithy himself.

Eagerly, Dick rose from his stool to examine the Veroboard panel. This was of 0.1 in. matrix and had mounted on it a capacitor, several resistors, a 14-way d.i.l. integrated circuit holder, a 16-way d.i.l. holder, together with seven light-emitting diodes near one corner of the board. These were arranged in a pattern having two vertical columns of three l.e.d.s with a single l.e.d. positioned centrally between them. Also connected to the board were two flexible leads passing to a push-button and two further leads, one red and one black, which were terminated in crocodile clips.

"This Veroboard," remarked Smithy, "is a 5 by $3\frac{3}{4}$ inch standard size, which takes all the parts just comfortably. Actually, the layout is of no importance at all, and any other means of assembling and wiring up the components will do equally well."

"What does your gadget do?"

"You'll see," promised Smithy. "Now, the only parts I've got left to wire in are four 1kΩ resistors which act as current limiting resistors for the l.e.d.s. And I've got these all ready."

Smithy put his hand in the cupboard once more and removed a small cardboard box. He opened this and took out a $\frac{1}{4}$ watt resistor, then glanced at a circuit diagram on one of the sheets of paper in front of him. He next held the resistor against the Veroboard, bent its two lead-outs through ninety degrees at the points dictated by the requisite holes in the board, then passed the wires through. Turning the board over, he soldered the lead-outs neatly to the copper strips through which they passed and then snipped off the excess wire. He proceeded to deal similarly with three further resistors, after which he examined the underside of the board carefully.

"This looks all okay to me," he pronounced. "All the joints are nice and sound and there's nothing silly like blobs of solder bridging adjacent strips. Right, now I'll plug in the integrated circuits."

He took a 14-pin i.c. from the cardboard box, removed the aluminium foil which short-circuited its pins together, and carefully inserted it into the 14-way d.i.l. holder.

"A CMOS i.c.?" queried Dick.

"A CMOS i.c.," confirmed Smithy. "Both the i.c.'s are CMOS types, which is the main reason why I used i.c. holders. There's no risk of damaging them if I fit them into holders when all the other wiring has been completed."

Quickly, Smithy removed the foil from a 16-way i.c. and then plugged this into the remaining holder. He then reached over towards the back of his bench and picked up a PP9 battery. He connected the crocodile clip at the end of the black flexible lead to its negative terminal and held the other clip poised over the positive terminal.

"Moment of truth now," he intoned. "Keep your fingers crossed, Dick!"

He connected the crocodile clip to the positive battery terminal. At once, all seven l.e.d.s lit up, glowing with a continual and pronounced flicker. Smithy gave a grunt of satisfaction.

"Right," he said briskly. "You press the push-button, Dick."

Dick picked up the button and pressed it. Three l.e.d.'s extinguished immediately, and the four at the corners of the display lit steadily. Dick released the button, then pressed it again. This time, only the single l.e.d. in the centre of the display remained lit. He released the button and pressed it yet again, to find that the two vertical rows of three l.e.d.'s stayed alight.

"Why, of course," he exclaimed, as realisation suddenly struck him, "it's an electronic dice!"

"That's right," grinned Smithy. "Every time you press the button the l.e.d.'s light up to form a number from 1 to 6, following the dot pattern on an ordinary dice."

"But," protested Dick, "you've got hardly any components at all on that Veroboard! Apart from the seven l.e.d.'s there are just the two i.c.'s, a capacitor and — let me see now — seven resistors only."

"True," agreed Smithy. "That's why I'm rather proud of this little circuit. It ***could*** be made up with only three resistors, as the four l.e.d. current limiting resistors I wired in just now aren't really essential. However, as you'll see soon, they are worthwhile including because they equalise the brightness of the l.e.d.'s."

## ORIGINAL IDEA

"Did you dream this up all on your own?"

"Not entirely," replied Smithy, disconnecting the positive crocodile clip from the PP9 battery. "This gadget is a development from several designs which were presented by an old colleague and friend of many years' standing, G. A. French."

"G. A. French," repeated Dick thoughtfully. "Do you mean the 'Suggested Circuits' geyser?"

"Geyser?" Smithy was profoundly shocked. "You mustn't refer to a person with the experience and ability of G. A. French as a geyser!"

Dick shrugged his shoulders.

"Oh all right then, the guy who does 'Suggested Circuits'."

Smithy glared at his assistant.

"You should have more respect," he said sternly, "for your elders and betters."

"Well, what were the ideas that G. A. French came up with?"

"They were concerned with the CD4018 integrated circuit," replied Smithy, still patently annoyed at his assitant's cavalier references to the author of the 'Suggested Circuit' series. "The CD4018 is a CMOS counter which has five not-Q outputs, and it can be made to divide by 10, 8, 6, 4 or 2 simply by returning the appropriate not-Q output to its data input. The not-Q outputs are numbered 1 to 5 and if, for instance, you want to divide by 10, you connect the not-Q5 output to the data input pin. To divide by 6, it's the not-Q3 output which is returned to the data input."

"Does the electronic dice application require the CD4018 to divide by 6?"

"It does," affirmed Smithy. "The CD4018 is advanced one count by each positive-going pulse edge applied to its clock input. If you apply the pulse edges through a press-to-break push-button you can then stop the CD4018 count at any one of its six ouput states, and this forms the basis for the electronic dice."

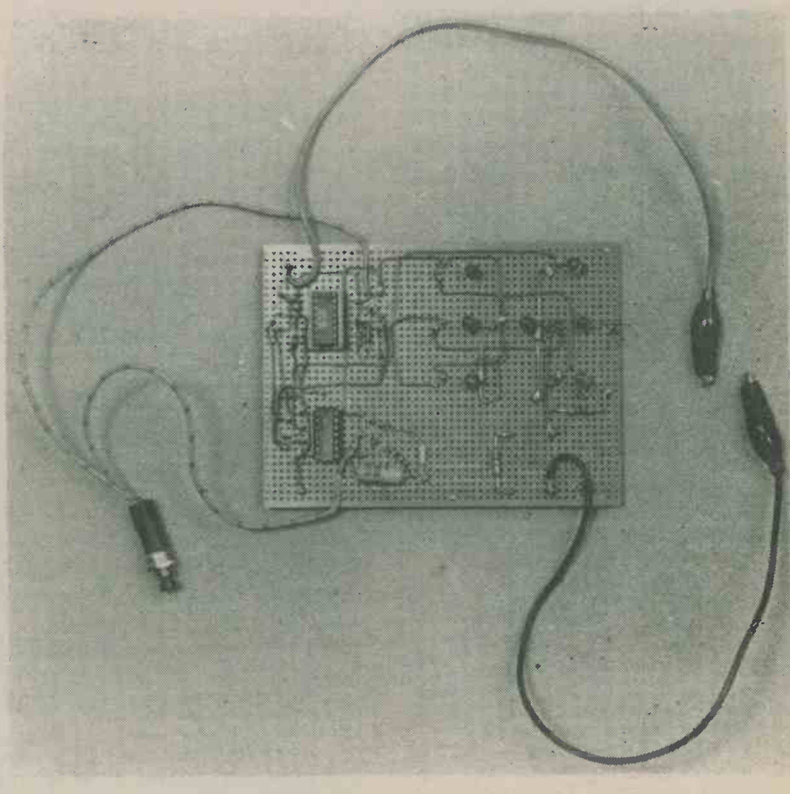
"Does the generator have to run at a fairly high frequency?"

"Oh yes," confirmed Smithy. "And it then becomes a purely random matter at which instant the push-button is pressed to stop the CD4018 counter."

"How do you manage to get the CD4018 to light up the l.e.d.'s in a dice pattern?"

"Ah," said Smithy, "that's the interesting bit. G. A. French has produced truth tables showing what happens at all of the CD4018 not-Q outputs for each successive count, and he then showed how these outputs could be gated to light up the appropriate l.e.d.'s in an electronic dice. I'm doing the same thing with my own dice design, but I've reduced the gating requirements to what may well be the minimum possible. To start off with, here is the CD4018 truth table when it's set up to divide by 6."

Smithy took one of the pieces of notepaper on which he had made out the truth table, and showed this



*The electronic dice may be assembled in any manner. Smithy found it convenient to mount all the small components, including the l.e.d.'s, on a standard size of 0.1 in. Veroboard*

| Count | CD4018 Output | | | | |
|---|---|---|---|---|---|
| | Not-Q1 | Not-Q2 | Not-Q3 | Not-Q4 | Not-Q5 |
| 1 | H | H | H | L | L |
| 2 | L | H | H | H | L |
| 3 | L | L | H | H | H |
| 4 | L | L | L | H | H |
| 5 | H | L | L | L | H |
| 6 | H | H | L | L | L |
| 7 | H | H | H | L | L |

***Fig. 1. Truth table illustrating the states of the CD4018 not-Q outputs over a period of seven counts when the not-Q output is connected to the data input***

to Dick. (Fig. 1.)

"After a few counts immediately after switching on," he continued, "the not-Q outputs settle into the pattern shown in this table. The letter 'H' stands for 'High' and indicates a positive output, whilst the letter 'L' stands for 'Low' and means a negative output. As you can see, the highs go progressively across the not-Q outputs followed by the lows. My truth table shows seven counts, and the seventh count is exactly the same as the first count. The eighth count will give the same results as the second count, and so on. The problem then consists of gating these outputs so that they light the right l.e.d.'s in the dice layout. And to do that we have to make up another table."

## DICE PATTERN

Smithy selected a further piece of paper, on which he had drawn out the dice l.e.d. layout. (Fig. 2.)

"You've given the l.e.d.'s letters,"

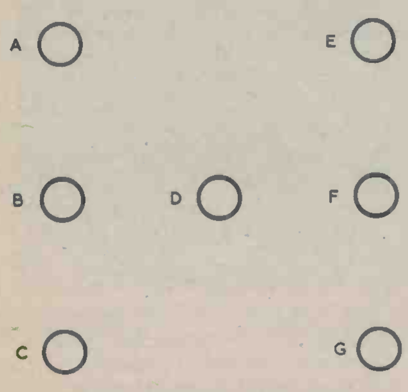



***Fig. 2. Seven l.e.d.'s laid out in a pattern which allows them to indicate dice numbers***

said Dick, looking down at the paper. "Is this to help you sort out which ones are lit for each number?"

"That's the idea," agreed Smithy. "And here's the table I made up which shows the lit l.e.d.s for each dice number. Number 1 is, of course, simply given by l.e.d. D lit up on its own." (Fig. 3.)

"And 2," chimed in Dick, "will be given when l.e.d.'s C and E are alight."

"3 comes next," said Smithy, "and that's given by l.e.d.'s C, D and E. For 4 we need the four outside l.e.d.'s, A, C, E and G. Add l.e.d. D to these and we've got dice number 5."

"Gosh, this is getting interesting! There's only dice number 6 left, and that must be given by A, B, C, E, F and G."

| Dice Number | L.E.D.'s Alight |
|---|---|
| 1 | D |
| 2 | CE |
| 3 | CDE |
| 4 | ACEG |
| 5 | ACDEG |
| 6 | ABCEFG |

***Fig. 3. Table showing the l.e.d.'s which require to be lit for each dice number***

"That's right," said Smithy briskly. "Well, I won't bother you with the details of how I sorted out the gating to light up the dice numbers, apart from telling you it involved a little head-scratching on my part, and I'll go straight on to the arrangements I finally settled for. Our last table shows that l.e.d. D lights up for dice numbers 1, 3 and 5. In my circuit this l.e.d. is driven direct, via a 1kΩ current limiting resistor, from the not-Q4 output of the CD4018 when this output is low. Like this."

Smithy took up a ball-point pen and scribbled out the circuit detail on the paper in front of him. (Fig. 4(a).)

"That means," said Dick slowly, "that l.e.d. D comes on at counts 1, 5 and 6 in the table which shows the not-Q outputs."

"Right! Incidentally, we'll ignore the seventh count in that table because it's the same as the first count. Next come l.e.d.'s A and G. These light up for dice numbers 4, 5 and 6. I've driven them directly from the not-Q2 output, and they light up when ***that*** output is low."

Smithy again sketched out the arrangement. (Fig. 4(b).)

"Well," said Dick, "these two l.e.d.'s are lit at counts 3, 4 and 5."

"Correct," confirmed Smithy. 'After this I had to introduce two NOR gates to handle the remaining four l.e.d.'s. You will note that l.e.d.'s C and E are alight for all the dice numbers apart from number 1. They're driven from the output of a NOR gate whose two inputs connect to not-Q3 and not-Q5."

Smithy drew out the circuit. (Fig. 4(c).)

"Well, the output of that NOR gate," said Dick, staring at the circuit, "will be low when one or both of its inputs is high, and will only go high, to turn off the l.e.d.'s, when the two inputs are low. Now, let's see. Ah yes, the two inputs, from the not-Q3 and not-Q5 outputs, are low only on count number 6."

"You've got it. We are now left with l.e.d.'s B and F. The opposite thing happens here, and these are only turned ***on*** for one dice number, this being dice number 6. They're fed from the output of a second NOR gate, but in this case they're returned to the negative rail."

Smithy drew the circuit. (Fig. 4(d).)

"The NOR gate input is taken from the not-Q1 and not-Q3 outputs," commented Dick, "and that means the gate output will only go high when its two inputs are low. Which occurs at count number 4?"

"It does," said Smithy. "Now I'll note down the l.e.d.'s corresponding to each count number. At count 1, C, D and E are alight, and at count 2, it's C and E. Count 3 brings on A, C, E and G, count 4 brings on A, B, C, E, F and G, while count 5 brings on A, C, D, E and G. The final count, 6, brings on D only."

Excitedly, Dick took the pen from Smithy's fingers.

"I'll add the dice numbers," he said quickly. "C, D and E obviously give dice number 3, and C and E must give dice number 2."

He quickly jotted the remaining dice numbers on the sheet of paper. (Fig. 5.)

"There you are," grinned Smithy. "How about that, then?"

"The dice numbers don't appear in numerical order," objected Dick. "They appear in the order 3, 2, 4, 6, 5, 1."

"That doesn't matter," said Smithy. "So long as each number appears only once in each 6-count cycle, it doesn't matter what order the numbers are in."

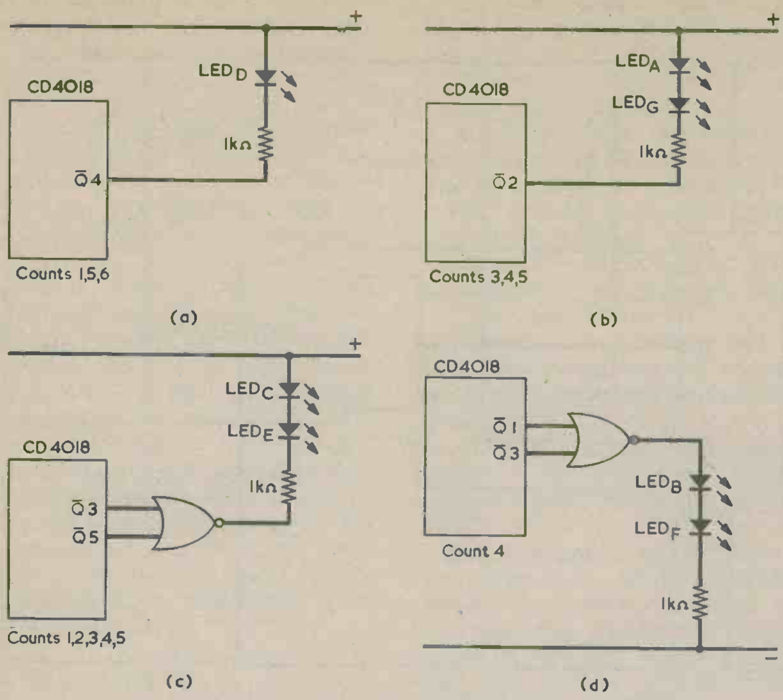



*Fig. 4(a). In Smithy's design, l.e.d. D is driven from the not-Q4 output of the CD4018, and it lights up on counts 1, 5 and 6*
*(b). The not-Q2 output drives l.e.d.'s A and G*
*(c). The not-Q3 and not-Q5 outputs are gated by a NOR gate to l.e.d.'s C and E*
*(d). A second NOR gate is used for l.e.d.'s B and F*

## COMPLETE CIRCUIT

"And all this," queried Dick. "was the result of studying G. A. French's CD4018 truth tables?"

"It was."

"That G. A. French must be a pretty crafty geyser, after all!"

Smithy turned a wrathful look on his assistant.

"It wouldn't half shake you," he snorted, "if all of a sudden a finger came creeping over the edge of the page and dug you one in the ear."

Dick blanched.

"Hey, Smithy," he said, shivering, "don't go saying things like that!"

| Count | L.E.D.'s Alight | Dice Number |
|---|---|---|
| 1 | CDE | 3 |
| 2 | CE | 2 |
| 3 | ACEG | 4 |
| 4 | ABCEFG | 6 |
| 5 | ACDEG | 5 |
| 6 | D | 1 |

*Fig. 5. Table listing the l.e.d.'s which light up at the counts of Fig. 1, together with the corresponding dice numbers*

"You should maintain a civil tongue."

"All right! I'm sorry!"

"Very well, then. I'll now go on to the complete circuit of the electronic dice."

Smithy sorted through the papers, then placed one in front of his assistant. (Fig. 6.)

"Here we are," he remarked proudly. "This is the full circuit. The gating and l.e.d. part of the circuit is to the right of the CD4018, and it follows the lines I've already shown you. The 1kΩ series current limiting resistors simply equalise the brightness of the l.e.d.'s, and make up for the fact that the output current capability of a CD4018 is lower than that of the NOR gates I've used. These are two NOR gates in a quad NOR gate type CD4001. I've made the circuit respectable by giving it an on-off switch, although I didn't bother about this on my own model. Pin number 8 of the CD4018 is the negative supply pin. There are also a number of inputs, a preset enable and a reset, and all their pins are taken to the negative rail as well. Pin 14 is the clock input."

"The not-Q3 output," observed Dick, "is on pin 6, and this is return-

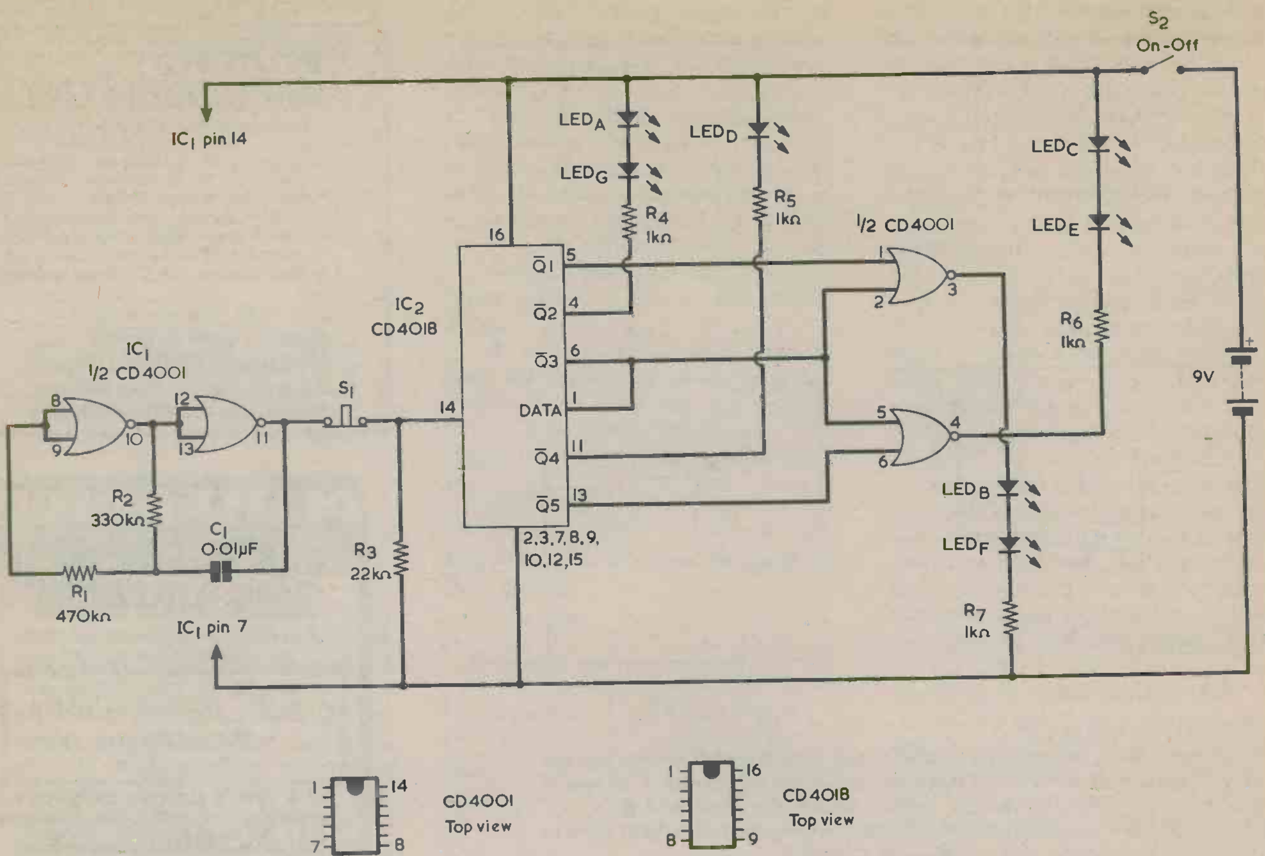



*Fig. 6. Complete circuit of the electronic dice. This requires very few components*

ed to pin 1 as well as going to the two NOR gates."

"That's right. Pin 1 is the data input pin and the connection to the not-Q3 output gives the CD4018 its divide-by-6 action."

"Is that the pulse generator to the left of the CD4018?"

"It is," said Smithy, "and it uses the remaining two NOR gates in the CD4001. It's a perfectly standard CMOS oscillator, and it has a frequency of about 150Hz. When you press push-button S1 you break the pulse input to the clock pin and R3 causes this pin to be taken to the negative rail. And that's about all there is to say about the circuit. Any reasonable sized 9 volt battery can be used to power the dice, and the current drawn from it varies between about 3mA and 15mA according to the number of l.e.d's which are alight."

Dick gazed down at the circuit, then frowned.

"There's one thing about this circuit that's worrying me a bit."

"What's that?"

"How do you ***know*** that the l.e.d.'s are going through the dice numbers you've just described to me? The generator is running so fast you can't possibly see that each dice number is appearing properly in its correct order."

"There's a very easy solution to that problem," said Smithy. "We simply slow the generator down! See if you can find a 2.2$\mu$F polyester capacitor in the spares cupboard."

Dick rose and proceeded smartly towards the spares cupboard. As he did so, Smithy looked around for a pair of crocodile clip leads. When Dick returned with the capacitor, the Serviceman used the leads to temporarily connect the 2.2$\mu$F capacitor in parallel with the 0.01$\mu$F capacitor in the pulse generator circuit. (Fig. 7.)

"That," he remarked, "should reduce the generator frequency to rather less than 1Hz. I'll connect the battery again."

He clipped the red lead from the board to the positive terminal of the PP9 battery. The l.e.d.'s of the electronic dice now proceeded to change at a slow rate, and in the correct order. Smithy picked up the push-button and pressed it. The l.e.d.'s stayed at the number they displayed. Smithy released the button and pressed it again. When he repeated the process a third time the l.e.d.'s jumped to a number which was not that showing when he pressed the button or the one which should have followed it.

"What happened then?"

"It's an effect similar to contact bounce," explained Smithy. "If you press the button when the generator output is high, and if the button contacts don't break cleanly, the CD4018 might hop through

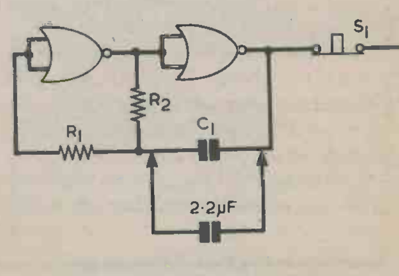



*Fig. 7. Temporarily adding a capacitor across C1 slows down the pulse generator and allows circuit operation to be checked*

several counts. It's an effect which doesn't worry us with the application we have here, since it can only add a random number to a number which is already random, but I thought I'd show it to you because the effect can be troublesome if the push-button is used in a circuit which has to count accurately."

"Is that the lot on this electronic dice?"

"Pretty well," stated Smithy. "The l.e.d.'s are driven by quite low currents from the CD4018 and the CD4001, and you will get a better visual effect if you use sensitive types. If you look through the mail-order catalogues and advertisements you'll see these described as 'extra bright' or 'ultra bright' or they will have a higher visible light ouput quoted. However, you don't *have* to use sensitive l.e.d.'s, as ordinary standard types will work quite adequately."

## FINAL POINTS

Smithy unclipped the 2.2μF capacitor, whereupon the pulse generator returned to its previous high frequency, causing the l.e.d.'s to flicker once more. Smithy pressed the push-button and the display steadied at number 5. He released and pressed the button again, whereupon number 5 was once more displayed.

"Hey, that's two 5's in a row!"

"That's all right," said Smithy. "You're liable to get the same number repeating several times with an actual dice also. Now, as I said at the beginning, the layout is not important. You could, for instance, house the electronics in a small box, with the l.e.d.'s and an on-off switch mounted on the front panel."

"Perhaps the box could be a die-cast one," said Dick brightly. "Or, would the risk of short-circuits make an all-metal box too dicey?"

Smithy sighed.

"To be accurate," continued Dick mercilessly, "we should call it a 'die' and not a 'dice', shouldn't we?"

He ignored the groan which arose from Smithy.

"But," concluded Dick triumphantly, "we never say die!"

"Have you finished?"

"If we were Welsh," went on Dick, as a further thought occurred to him, "we could call your gadget a 'Dai-Electric'!"

"That's enough," thundered Smithy. "You and your diabolical puns! Ye gods, you've got me at it now!"

But, fortunately for the peace of the Workshop, Dick's inventive powers were now exhausted, and he and the Serviceman settled down happily to a simple game of dice with Smithy's device of only two i.c.'s. After which they put away the dice and returned to their real and proper world of finding fortuitous faults in randomly chosen radio and television receivers.

■

## EDITOR'S NOTE

Previous articles by G. A. French dealing with the CD4018 were "Illuminated Dice" (April 1979 issue), "Electronic Dice" (February 1978) and "CD4018 Truth Tables" (June 1977).

Copies of the issues containing the above articles are available. Price 63p each, inclusive of postage.

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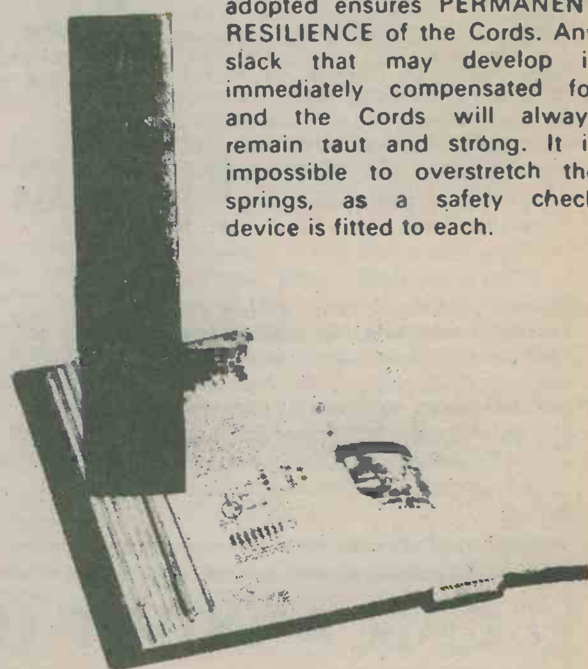

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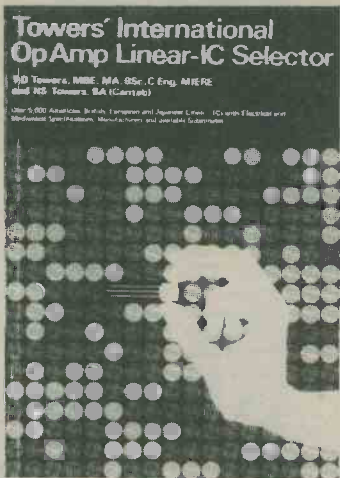


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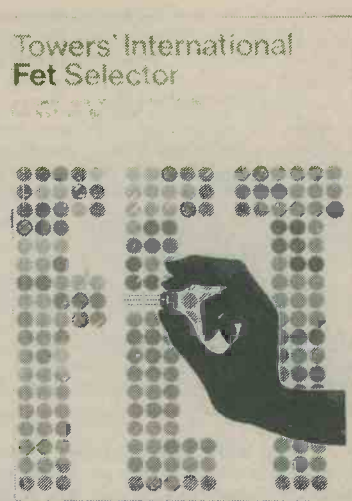


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(Continued on page 127)

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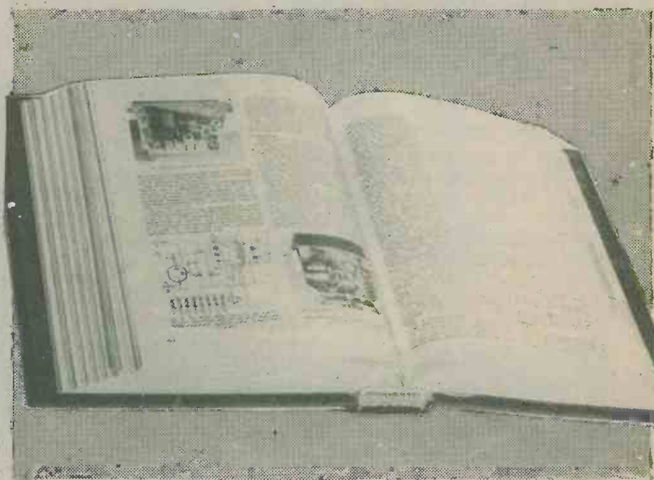

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(Continued from page 125)

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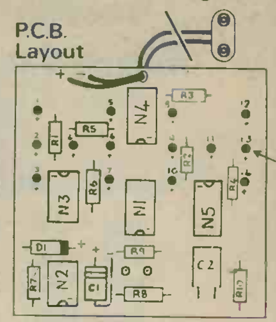

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# TRANSFORMER CURRENTS

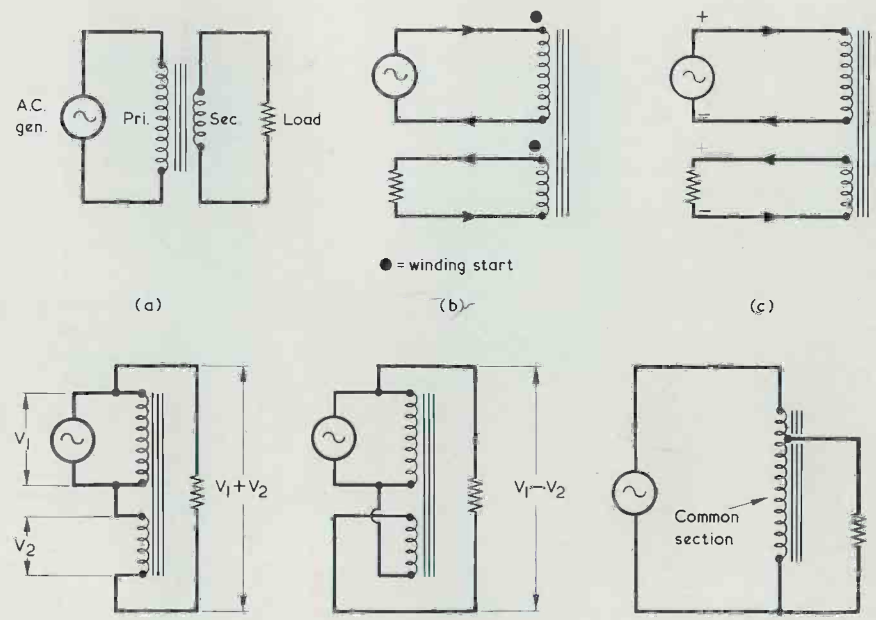
In (a) an a.c. generator couples to the primary of an iron-cored transformer, and the secondary connects to a load. An alternating voltage whose magnitude depends on the turns ratio of the transformer appears across the load. The current induced in the secondary flows in the *opposite* direction to that flowing in the primary.

The current directions can be more readily visualised by drawing the primary and secondary on the same side of the core, as in (b). Both windings are wound in the same direction. At an instant when the upper terminal of the generator is positive, current (assumed to flow from positive to negative) flows in the primary as indicated. The induced current in the secondary flows into the load as shown.

This is not an anomalous situation, and it explains the behaviour of transformer windings when connected in series. As can be seen in (c), when the upper end of the primary is positive (current passing in) so also is the upper end of the secondary (current passing out).

In (d) we join the primary and secondary in series, and the voltage from the secondary adds to the voltage from the generator. When connected as in (e) the voltage from the secondary is subtracted from that from the generator.

In the autotransformer of (f), a common section of the winding carries both primary and secondary currents. Since these flow in opposite directions, the actual current is the smaller subtracted from the larger and, for secondary voltages greater than half the primary voltage, is less than the current from the generator. In consequence the common section may be wound with thinner wire than the non-common section above it.



(a) (b) (c) (d) (e) (f)